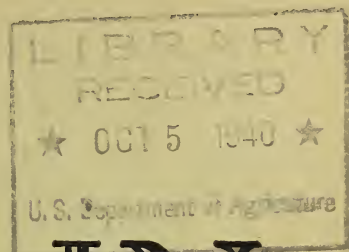


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GRAIN

Grading Primer

MISCELLANEOUS PUBLICATION

No. 325 *rev. Aug. 1940*

UNITED STATES DEPARTMENT
OF AGRICULTURE

THE Grain Grading Primer is designed for grain farmers and country grain dealers, interested in handling grain on a grade and quality basis, and for marketing students. It is not designed for grain inspectors, for they must necessarily use a more precise and detailed grain-grading technique than that described herein.

A number of farm practices that lower the quality and grade of grain are briefly discussed in this publication. Methods and apparatus useful in measuring the value of grain are described and information on how to inspect and grade grain is given.

The detailed specifications of the official grain standards are contained in the Handbook of Official Grain Standards of the United States, U. S. G. S. A.—Form No. 90, Revised 1939.

A copy of this handbook may be obtained free of charge from the Agricultural Marketing Service, U. S. Department of Agriculture, Washington, D. C., or from any Grain and Seed field office of the Agricultural Marketing Service, located in the principal grain markets of the country. It may also be obtained from the Superintendent of Documents, Washington, D. C., at 10 cents a copy.

UNITED STATES DEPARTMENT OF AGRICULTURE

MISCELLANEOUS PUBLICATION NO. 325

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Issued November 1938
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GRAIN GRADING PRIMER

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DEVELOPMENT OF GRAIN GRADING

As the Mississippi Valley was gradually brought under cultivation the surplus grain in increasing quantity moved eastward to consuming centers and to the eastern seaboard by rail, lake, river, and canal. There was need for a readily understandable commercial language to express the class, quality, and condition of individual lots of grain so that buyers and sellers at separate points could trade without a personal examination of the grain itself or without an exchange of samples. Grain trade organizations, therefore, instituted a system of grain grading whereby grain could be bought and sold by grade without having either the grain itself or samples of it before the interested parties.

Each trade organization adopted its own set of standards and its own method of application. The grades themselves were set forth in

¹ This publication was issued in 1938 as a joint contribution from the Extension Service and the Bureau of Agricultural Economics. In July 1939 the work on grain grading and inspection was transferred to the Agricultural Marketing Service.

The late William P. Carroll collaborated in the preparation of this publication in 1937. The authors acknowledge the aid received from E. G. Boerner, O. F. Phillips, and Hazen P. English, senior marketing specialists, Agricultural Marketing Service, especially in furnishing information on inspection procedure.

such ambiguous terms as "dry," "damp," "plump," "well-cleaned," "unsound," and "unmerchantable."

EARLY GRAIN-GRADING PRACTICES

In some markets different interests favored different kinds of grain standards. The millers generally preferred high standards, well maintained, whereas other interests that made their profits mostly from the volume of grain handled, frequently favored liberal standards, leniently applied for the sake of attracting shipments to their market.

Persons buying grain under a certain designation in one market had little assurance that the grain would receive the same grade designation in some other market. Exporters who bought grain at interior markets for delivery abroad had no way of knowing that the grain bought by grade at interior points would be assigned the same grade when loaded aboard ship for export. Millers hesitated to make future contracts, to accept the grades of grain then specified. Sometimes they refused to accept such deliveries because they had no confidence in the way in which the standards had been applied. Indefinite grading and lack of confidence in grain grading had a strong tendency to depress prices of grain sold by grade, especially for deliveries that were to be made at some distant future date.

FEDERAL LEGISLATION

For many years grain organizations tried to bring about a more consistent application of a single set of standards. But the results were disappointing. The lack of any effective agency to establish a single set of standards for grain that would be applicable throughout the United States and to insure uniform application, kept the grain-grading system defective during this period of localized and unrelated grain-inspection departments.

Foreign-trade organizations and individual receivers of American grain filed complaints with the United States Government on account of the unsatisfactory condition of graded grain received from American ports. But at that time the Federal Government had no jurisdiction over the numerous State and commercial grain-inspection departments operating throughout the country. In 1901 the United States Department of Agriculture organized an investigational project for studying the structure of the commercial grain standards then in effect and the methods by which they were applied. As a result, in 1913, permissive Federal standards for shelled corn were established. Shortly afterwards these standards were adopted by many grain-inspection departments even before the United States Grain Standards Act was passed in 1916. But a serious lack of uniformity in the application of the standards continued.

The demand for uniform grades and inspection resulted in the introduction, in the Fifty-seventh to the Sixty-fourth Congresses, covering the years 1903 to 1916, of 26 different bills providing either for Federal supervision of grain grading or for outright Federal grain inspection. Extended hearings were held on several of these bills. The United States Grain Standards Act was finally passed August 11, 1916.

The act provides in part for (1) the establishment of official grain standards, (2) the Federal licensing and supervision of the work of grain inspectors, and (3) the entertaining of appeals from the grades assigned by the licensed inspectors. The Secretary of Agriculture is authorized to make investigations and to establish Federal standards for the most common grains. Federal standards under this act are now in effect for wheat, corn, barley, oats, Feed Oats, Mixed Feed Oats, rye, grain sorghums, flaxseed, and Mixed Grain.

GRAIN INSPECTION UNDER THE UNITED STATES GRAIN STANDARDS ACT

The Grain Standards Act provides in part that all grain shipped in interstate or foreign commerce to or from a point at which an inspector, licensed under the act, is located must be officially inspected and graded if the grain be merchandised by grade. As most of the grain that reaches any important grain market is moving in interstate or foreign commerce by grade it is necessary, for practical purposes, that the grain inspectors hold Federal licenses to inspect and grade grain.

Most of the licensed grain inspectors are employed by States or trade organizations. They are paid salaries by the agencies that employ them. Some licensed inspectors work independently for fixed fees, paid by those who request these services. No licensed grain inspectors are employed by the Federal Government.

The grain-grading activities of all federally licensed grain inspectors are supervised by Federal grain supervisors employed by the United States Department of Agriculture and stationed at the important grain markets. In the first instance, grain is graded by a licensed grain inspector. Any person financially interested in the grade of any lot of grain may appeal from the grade assigned to it by a licensed inspector to the Secretary of Agriculture, through the local grain supervisor.

The provisions for uniform grain standards, the general supervision by the Federal Government of grain inspection, and the provision for appeals to Federal agents afford protection as to correct grading to all handlers of grain who wish to avail themselves of these services.

USEFULNESS OF GRADES IN EXPORT COMMERCE

Since the Grain Standards Act has been in effect much grain exported from the United States has been sold on the basis of the official standards, evidenced by inspection certificates issued under the act. When grain is sold by grade and on the basis of "U. S. certificate final," all questions as to the grade of the grain delivered are settled when the grain is graded for export. The exporter is not required to assume any further risk from arbitration or from any subsequent grading.

BENEFITS OF STANDARDIZATION

Grain standards function as commercial measures of quality and condition. They assist in the economical marketing of grain because

their use reduces risks and promotes definite agreements between contracting parties.

Grain grading permits the great economy of bulk storage and transportation of grain of similar grades. It facilitates financing and trading on the basis of warehouse certificates representing grain of known quality and value.

Grain grading, and market quotations based on grade, assist producers and handlers of grain to market their grain advantageously.

The application of the grain standards shows the causes for market discounts and indicates ways and means for crop-improvement and grain-handling practices that will bring about a reduction of certain "off" grades of preventably low quality.

S. J. Duly, of the City of London College, who has made a special study of the grain trade and is a recognized authority on grain merchandising, comments on the benefits of standardization, as follows:²

The advantages of the grading system are many. It is essentially a farmer's system. It is his safeguard. Grading takes place in the country of production and it provides the required incentive to the farmer to farm well, since he has the assurance that his return will be determined by the quality of his crop. His grading certificate provides him with bank credit immediately. Then grading is the absolute prerequisite of bulk handling. If grain is not graded, it cannot be bulked with other grain, but must retain its identity and be sampled frequently for selling purposes. The immense economy of the terminal storage system is only possible after dependable grading. Next, it provides the basis upon which organized marketing with future sales and hedging alone becomes possible. This forms the most economic machinery for financing the crop, paying cash to the farmer months before the grain is exported, holding it, transporting it, and getting it to the miller. Finally, it provides the last buyer with a standard article upon which he may depend, in the same manner that buyers depend on the trade-mark of manufactured goods of reputable firms. The main disadvantage from the point of view of a European buyer is the impossibility of disputing the grade and securing arbitration upon questions of quality or condition when once the grain is sold on grade for shipment abroad. It thus appears to be essentially a system of an exporting country. It only becomes a possible international system on certificate final terms when experience shows (as it does) that the grading in the exporting country is entirely dependable.

GRAIN-GRADING FACTORS

FACTORS AFFECTING GRADES

To establish dependable grain standards, means must be provided for determining precisely the correct grade of any given lot of grain on the basis of the standards. Appearance of the grain has been found unreliable for determining grades because all of the essential factors cannot be determined by appearance alone. The requirements of each grade in any set of practical grain standards should therefore be plainly expressed and the specifications should, so far as possible, be in language that is incapable of misunderstanding or of readily yielding to more than one construction.

Some of the indexes of grain quality that producers and consumers have always considered important are soundness, plumpness, cleanliness, dryness, purity of type, and the general condition of the grain. Because of the importance of these qualities in measuring the value of grain, specifications, for measuring each of these characteristics have been incorporated in the standards for determining grades of

² DULY, S. J. GRAIN. 163 pp., illus. London. 1928. See p. 83.

the different grains. In the official standards these factors are measured by test weight per bushel, damaged kernels, foreign material, moisture content, the class of the grain, and mixtures of other classes.

To these factors may be added the general condition factors of grain—as to whether it is musty, or sour, or heating, or cool, or sweet; or whether it contains odors that are not usual in grain. Other important factors in measuring the quality of grain are color—whether natural or weathered—and the presence in the grain of smut, ergot, garlic bulbs, stones, and insects such as weevils.

These factors of quality and condition, with the exception of certain condition factors like mustiness and other odors, can be measured with considerable definiteness. In the official grain standards, therefore, each grading factor has definite specifications as to minimum requirement or maximum tolerance in each of the numerical grades. (See Handbook of Official Grain Standards.)

FACTORS ON WHICH THE OFFICIAL GRAIN STANDARDS ARE BASED

The grades in the official standards for grain are based on the class, quality, and condition characteristics of the grain.

“Class” in general is based on (1) both kernel characteristics and color, as in the cases of Hard Red Spring Wheat and Soft Red Winter Wheat, or (2) color alone, as in the case of the classes Yellow Corn or White Corn, or (3) both color and the characteristics resulting from the area of production, as in the case of the classes Barley (class I) and Western Barley (class III). Many of the classes for the different kinds of grain are divided into subclasses based on various characteristics. Examples of classes and subclasses follow: Class Hard Red Winter Wheat with subclasses Dark Hard Winter, Hard Winter, and Yellow Hard Winter; class Barley (class I) with subclasses (A) Malting Barley and (B) Barley; class White Grain Sorghums with subclasses White Kafir, White Durra, and White Grain Sorghums.

“Quality” in general refers to such characteristics as plumpness, soundness, and cleanliness of the grain. These characteristics are determined by the application of the grading factors “test weight per bushel” and “damaged kernels” for some of the grains, and “sound kernels” for certain other kinds of grain, and “dockage” or “foreign material.” Quality also refers to kernel texture for some of the grains such as dark, hard, and vitreous kernels in wheat.

“Condition” in general refers to moisture content, the odor of the grain, and the condition of the grain with reference to whether it is in sound condition or is out of condition as the result of fermentation or mold growth. The term “condition” also refers to the freedom from or the presence in the grain of smut, garlic, live weevils, ergot, inseparable stones and cinders, to staining or weathering, and to any artificial treatment that the grain may have received by washing, scouring, liming, or bleaching.

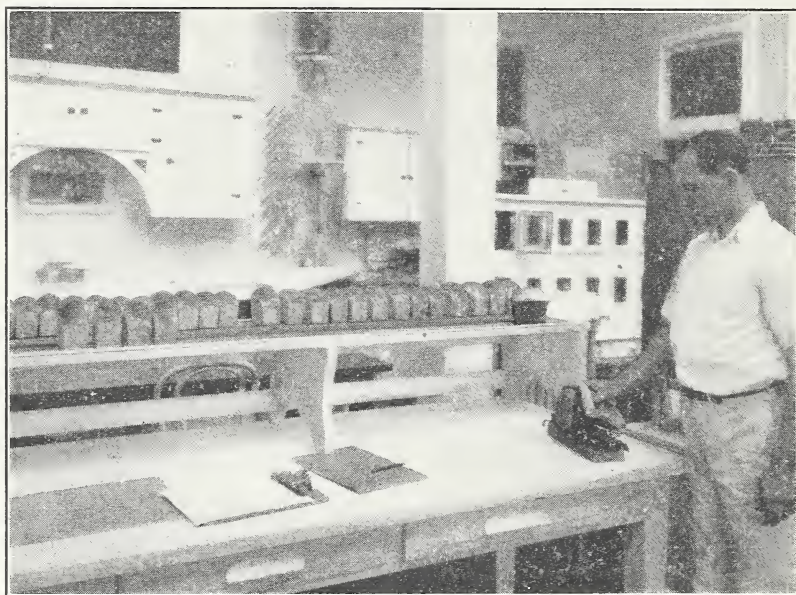
Class.—When grain inspection was first established the varieties of grains were few compared with the number now prevailing in different localities. Earlier classification of wheat was comparatively simple. Flour mills, for example, did not then make the speciality flours that the baking trade now requires. Now grain standards must provide diverse classifications to meet variations in quality arising

from numerous grain varieties and production conditions as well as to meet the diverse requirements of grain users.

Hard Red Spring Wheat and Hard Red Winter Wheat are specially suited for the making of bread flour. These two wheats contain a large quantity of strong elastic gluten—an essential element in making a bread that meets the public favor in the United States.

Durum wheat is used for making semolina that is especially suited for the manufacture of macaroni, spaghetti, vermicelli, and other alimentary pastes. The principal use for Red Durum Wheat is for poultry and stock feed.

Soft Red Winter and White Wheat flours, both usually low in protein content, are specially suited for making pastry, crackers, biscuits, and cakes, and similar products. The suitability of new wheat varie-



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FIGURE 1.—Baking laboratory where wheat is tested experimentally to ascertain its value for bread or pastry making.

ties for various purposes is determined by milling and baking tests (fig. 1). Table 1 shows the classification of all the grains.

Texture in wheat.—Texture in wheat refers to the hardness or softness of the kernels, which qualities in turn are indications of the glutinous or starchy character of the kernels. In the case of the common wheats, any wheat that consists principally of hard kernels usually has a comparatively high quantity of protein and is well adapted for bread-making purposes; and any wheat that consists principally of starchy kernels usually has a comparatively low protein content and is best adapted for biscuit and pastry-making purposes. In the case of durum wheat (not red durum), any wheat that consists principally of hard and vitreous kernels is well adapted for the manufacture of high-quality semolina flour.

TABLE 1.—Classes, subclasses, and areas of production

Grain and class	Subclass
Hard Red Spring Wheat. Grown principally in Minnesota, North Dakota, South Dakota, Montana, a little in western Kansas and western Nebraska, in restricted areas in the Mississippi Valley, and to a lesser degree in the intermountain and north Pacific coast areas.	(A) Dark Northern Spring. (B) Northern Spring. (C) Red Spring.
Durum Wheat. Grown principally in North Dakota, South Dakota, and Montana; also in small scattered areas on the Great Plains.	(A) Hard Amber Durum. (B) Amber Durum. (C) Durum.
Red Durum Wheat. Grown principally in North Dakota, South Dakota, Minnesota, and Wyoming.	
Hard Red Winter Wheat. Grown principally in States west of Mississippi River, and to a minor extent north of the Ohio River in Illinois and Indiana.	(A) Dark Hard Winter. (B) Hard Winter. (C) Yellow Hard Winter.
Soft Red Winter Wheat. Grown principally east of the Great Plains and south of Wisconsin. Scattered areas in Texas, Oklahoma, Kansas, and northwest Pacific Coast States.	(A) Red Winter. (B) Western Red.
White Wheat. Grown principally in the Pacific Coast States, Michigan, northern Ohio, and New York. (White Club is grown principally in Pacific Coast States and in Utah and Idaho.)	(A) Hard White. (B) Soft White. (C) White Club. (D) Western White.
Mixed Wheat (Classified as Mixed Wheat, Amber Mixed Durum, or Mixed Durum).	
Barley (class I). Grown east of the Rocky Mountains.	(A) Malting. (B) Barley.
Western Barley. Grown west of the Great Plains region.	
Black Barley. Very small scattered production.	
Mixed Barley.	
Rye. Grown principally in North Dakota, South Dakota, Minnesota, and eastward and north of Ohio River.	
Grain Sorghums. Grown principally in Texas, Oklahoma, Kansas, and California.	
White Grain Sorghums.	(A) White Kafir. (B) White Durra. (C) White Grain Sorghums.
Yellow Grain Sorghums.	(A) Yellow Milo. (B) Yellow Grain Sorghums.
Red Grain Sorghums.	(A) Red Kafir. (B) Red Grain Sorghums.
Brown Grain Sorghums.	
Mixed Grain Sorghums.	
Corn. Grown principally between Allegheny and Rocky Mountains.	
(I) White Corn.	
(II) Yellow Corn.	
(III) Mixed Corn.	
Flaxseed. Grown principally in Minnesota, North Dakota, South Dakota, California, and in a few Midwestern States.	
Oats: ¹	
(I) White Oats. Grown generally throughout the United States but mostly in the northern half.	
(II) Red Oats. Grown mostly south of the Ohio River and in Texas, Oklahoma, and Kansas.	
(III) Gray Oats.	
(IV) Black Oats. Grown in scattered areas and the production is small.	
(V) Mixed Oats.	
Mixed Grain: Usually caused by mechanical mixtures but sometimes by planting or by volunteer growths.	

¹In addition to the standards for oats, standards have been established for Feed Oats, and Mixed Feed Oats.

Texture is specified in the wheat standards in terms of "dark, hard, and vitreous kernels" in the case of hard red spring and hard red winter wheats, in terms of "hard (not soft and chalky) kernels" in the case of white wheat, and in terms of "hard and vitreous kernels of amber color" in the case of durum wheat.

The classes, Hard Red Spring, Hard Red Winter, White, and Durum are each divided into subclasses, all but one of which is wholly or largely based on texture.

The texture specifications in the standards for wheat provide a practical means for making estimates of the gluten properties in wheat when chemical tests are not available.

Color in corn.—Color in corn has become increasingly important now that so many modern food products are made from this grain. In the manufacture of white corn meal and white corn grits a very small percentage of kernels other than white will somewhat affect the color of the product.

A mixture of white corn in yellow corn is not so objectionable as a mixture of the same quantity of yellow corn in white corn.

Color in oats, barley, and grain sorghums.—Oats are classified by color, as white, red, gray, black, or mixed, and grain sorghums are classified as white, yellow, red, brown, or mixed. The black (glumes) barley (class II) is placed in a separate class from the white (glumes) barley. The latter, however, is classified by areas of production, Barley (class I) being that grown east of the Rocky Mountains and Western Barley (class III) being that grown west of the Great Plains region.

Dockage defined.—In the inspection and grading of grain the official grain standards provide for a system of dockage determination and record for all wheat, rye, barley, grain sorghums, and flaxseed.

Dockage in wheat and rye is defined as any foreign material that can be readily removed from either of these grains by the use of appropriate sieves and cleaning devices; and any undeveloped or shriveled grains and small pieces of either of these grains removed in properly separating the foreign material and which cannot be recovered by properly rescreening.

Dockage in barley includes all matter that can be removed from the barley by the use of a metal scalper riddle with slotted perforations nine sixty-fourths of an inch wide by three-fourths of an inch long and by the use of a 20-gage metal sieve with equilateral triangular perforations the inscribed circles of which are five sixty-fourths of an inch in diameter.

Dockage in grain sorghums includes sand, dirt, finely broken kernels, weed seeds, and other foreign material that can be removed readily from the grain sorghums by means of a metal sieve perforated with round holes two and one-half sixty-fourths of an inch in diameter.

Dockage in flaxseed includes all matter other than flaxseed which is contained in the lot of grain as a whole; also undeveloped, shriveled, and small pieces of flaxseed removed with the dockage and which cannot be recovered by properly rescreening or recleaning.

Foreign material other than dockage.—The foreign material that cannot be removed as dockage in wheat, rye, and barley is commonly referred to as "foreign material." In wheat and rye the foreign material that remains in the grain after the removal of dockage usually consists of the larger seeds of wild buckwheat, vetch, corncockle, kinghead, wild rose, chess, quackgrass, small kernels of barley, oat groats, and other seeds and grains similar in size to wheat or rye kernels. Milling and baking tests show that these impurities are objectionable.

Rye, when present in significant quantities, in wheat results in darkening the flour. The yield of flour made from wheat that contains rye is also reduced.

Corncockle in wheat adversely affects the volume, color, and texture of the loaf and may reduce the percentage of water absorption in the flour. Particles of the outer coating of the cockle seeds frequently appear as black specks in the flour made from wheat that contains cockle.

Foreign material in oats usually consists of small weed seeds that can be readily removed by sieves, and of straws, weed stems, and similar trash. In certain districts it is not uncommon to find considerable mixtures of other cereal grains and wild oats growing with the oats, with consequent mixtures in the threshed grain.

Cracked corn and foreign material.—Corn is usually free from material other than corn. Small broken pieces of corn are the principal ingredients in "cracked corn and foreign material." Cracked corn is sometimes caused by setting corn shellers too closely or by shelling the corn when it is too wet; but excessive quantities of cracked corn arise principally from the quick-drying practices that are sometimes used in the artificial drying of corn. High-moisture corn that has been dried very rapidly and with excessive heat is broken easily when it is handled by ordinary commercial practices through modern grain elevators.

Objections to foreign matter in grain.—Some of the foreign matter (such as other grains and wild oats) is valuable for feed but most of the foreign matter is worthless, and to remove it from the grain may be costly. Much of the foreign matter, like finely broken grains and fine dust, contributes toward the grain heating or becoming musty, if it has a high moisture content. Foreign matter is often detrimental because of its effect upon the products manufactured from the grain. For these reasons the official grain standards provide the dockage system for some grains and limitations for foreign matter in the grades.

Test weight per bushel.—For many years plumpness has been considered an important characteristic of good grain. This quality is ascertained and expressed by the test weight in terms of pounds per measured (struck) Winchester bushel. Test weight per bushel is an important index of the pounds of flour that may be milled from a bushel of wheat, the largest flour yields being obtained from wheat of high test weight per bushel and relatively low yields of flour from wheat of relatively low test weight per bushel. For this reason millers prefer wheat of high test-weight-per-bushel quality, and premiums are often paid for such wheat.

The equipment used by inspectors in making test-weight-per-bushel determinations is shown in figure 2. Detailed instructions for making this test are given in Department Bulletin No. 1065.

Moisture content.—Dryness has always been a much-sought-after quality in grain. Any grain that contains moisture in excess of its normal air-dry condition is nearly always unsafe for storage, especially if the grain is stored at a high temperature. Threshing and combining operations should not start until the moisture content of grain is 14 percent or less.

Wheat that contains more than approximately 14 percent of moisture often will spoil during storage or transportation, and it may spoil even with a lower moisture content in warm climates or under improper storage conditions. Damp grain cannot be satisfactorily milled for either flour or feed. Damp flour and damp feed will not long remain cool and sweet in storage.

Shrunken and broken kernels in wheat.—There is a serious objection to mixtures of shrunken and broken kernels with wheat of high test weight because the shrunken kernels adversely affect the flour yield. The official standards for wheat provide limitations in the top



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FIGURE 2.—Determining the test weight per bushel of grain in a grain inspection laboratory.

three grades for shrunken and broken kernels in the dockage-free grain. Although shrunken kernels may be found in all classes of wheat, Hard Amber Durum is probably the most subject to broken kernels because of its extreme hardness.

Skinned and broken kernels in barley.—Skinned and broken kernels are objectionable in barley intended for malting purposes as such kernels are either removed in preparing barley for malting or do not germinate satisfactorily. Broken kernels in barley cause production losses in the pearling industry.

The breaking of wheat kernels and the skinning and breaking of barley kernels can be avoided to a large extent by careful threshing.

The adjustment and speed of the cylinder, the number and setting of concaves, and the rate of feeding as well as other mechanical adjustments all affect the breaking or skinning of the threshed grain. The moisture in the grain changes throughout the day which makes necessary the adjustment of the machine at regular intervals to avoid damaging this crop.

Damaged kernels.—Damaged kernels are objectionable in grain. Soundness is a quality of considerable importance in evaluating grain for commercial use. The official grain standards for most grains permit only a small percentage of damaged kernels in the No. 1 grades with increasing percentages of damaged kernels tolerated in each successive grade below No. 1. In the case of oats and barley the standards require a high percentage of sound kernels in the No. 1 grade.

Damaged kernels may be divided into types—field damage and storage damage. In turn, field damage may be subdivided into two kinds—preventable and nonpreventable. Frost damage, and such fungus damage as scab and cobrot, may be considered practically beyond the control of the grower, although much of the damage caused by such fungus diseases as scab and cobrot may be reduced by crop rotation and seed treatment. On the other hand, grade loss from sprouted grain and stack-stained, ground-damaged, and weather-damaged kernels, and damage resulting from such fungus diseases as smut are more or less preventable.

Storage-damaged grain includes heat-damaged, weevil-damaged, and moldy grain. Damage caused in storage usually is preventable because it all takes place in the storage bins which are under the control of the operator of the storage facilities. Ventilation or artificial drying of high-moisture grain, and fumigation are the usual means for preventing damage in storage. Ordinarily more grain is damaged during storage than from all sources of damage to grain in the field.

Effect of damaged wheat on flour quality.—The different kinds of damaged wheat kernels affect the milling and baking quality of the flour in different ways.

Frosted wheat, when the entire seed coat is badly affected, produces a flour of poor dough quality and is unsatisfactory for the production of good bread.

Heat damage in wheat is perhaps more objectionable than any other, because wheat so injured produces a flour poor in color and of unsatisfactory bread-making properties. Bread from such flour is small in volume, the crumb is discolored, the texture is very poor, the bread has an offensive odor and usually tastes bad (fig. 3).

Heat damage in its early stages affects, among other things, the bran or the pericarp protective covering of the kernels. Such damaged kernels are commonly referred to as skin-burnt and possess unsatisfactory milling and baking properties. Similarly, stack-stain or header damage caused from stacking grain that is not fully ripened and consequently is high in moisture content, produces flour of inferior bread-making qualities.

Moldy wheat is often caused by storing damp wheat under unfavorable conditions. Such wheat usually develops a musty odor that will ultimately be transmitted to the products made from the flour.

Other factors.—Several other factors occasionally function in determining the grade of grain but they are of minor occurrence and are largely self-explanatory in the standards. These factors include presence of stones and cinders, and special limits of "other classes," and commercially objectionable odors.

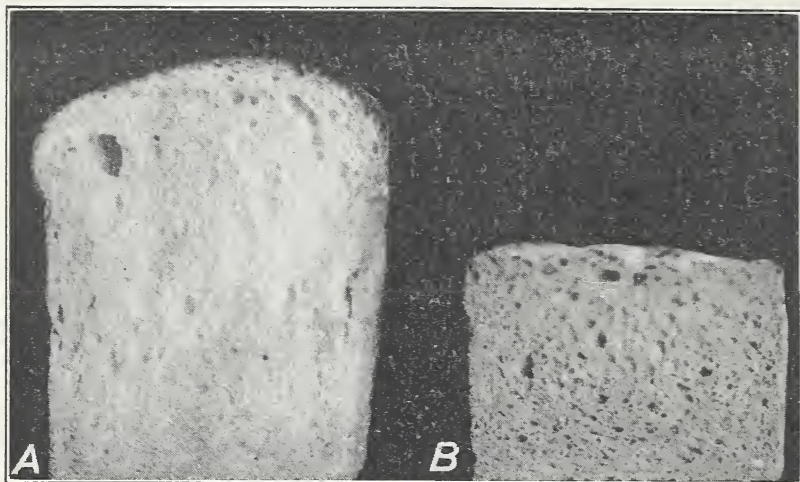


FIGURE 3.—A, Loaf of bread made from flour milled from sound wheat; B, loaf of bread made from flour milled from wheat that contained a mixture of heat-damaged grain. Heat-damaged wheat makes poor bread.

SPECIAL GRADE DESIGNATIONS

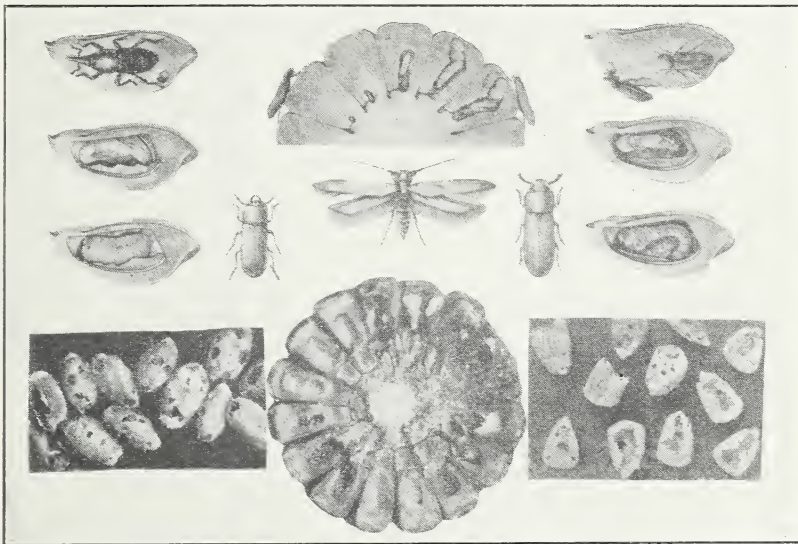
The official grain standards for grain provide special grades for certain grains that are of superior quality according to test weight and general appearance, also for grains that have been artificially treated, that contain excess moisture, that contain certain kinds of extraneous material such as garlic, or that have been affected by fungi such as smut. This is necessary because the commercial quality of such grain is not reflected by the numerical grade alone.

Garlicky grain.—Wild garlic and onion bulblets are frequently found growing with soft red winter wheat. The presence of wild garlic or onion bulblets frequently causes a substantial reduction in the price millers will pay for the grain. Wild garlic and onion bulblets in wheat are objectionable because they clog the rolls of the mill during the grinding process, thus reducing the efficiency of the milling machinery, and because flour made from garlicky wheat often is tainted with garlic odor. For these reasons garlicky wheat usually is subject to price discounts.

Smutty grain.—Smut in wheat and rye is objectionable because the smutty odor may pass into the flour and the black smut spores may discolor it.

The official grain standards permit a small tolerance of smut in wheat, rye, barley, oats, Feed Oats, Mixed Feed Oats, grain sorghums, and Mixed Grain. If the tolerance specified in the grain standards for each kind of grain is exceeded, special grade designations pertaining to the smutty condition of the grain are applied.

Tough grain.—For wheat, rye, barley, oats, and Mixed Grain, the standards provide a maximum moisture limitation for all numerical grades and when the moisture exceeds these limits up to a specified percentage the word "Tough" is added to the grade designation. There is a maximum limit to the moisture content of the Tough grades and when this limit is exceeded the grain is then placed in Sample grade. Special grades for tough grain are not provided for corn, grain sorghums, and flaxseed. The reason for this in case of corn and grain sorghums is that the wide moisture range in these grains during harvest time and for some months following requires the use of moisture content as a numerical grade and Sample grade determining factor to properly indicate storage and dry-matter values.



BAE 24295

FIGURE 4.—Grain kernels damaged by weevils and other insects injurious to stored grain.

Weevily grain.—The official grain standards provide that grain shall be graded "Weevily" if infested with live weevils or other insects injurious to stored grain (fig. 4). Some insects eat the grain, while others bore into it and lay eggs in the kernels. These eggs hatch into larvae that feed upon the interior of the kernels. Weevil-infested grain generally is useless for seed and its value is low for processing because the kernels may be so gnawed and bored by the growing larvae or mature weevils that little or no substance is left. Besides consuming the grain the weevils leave much offensive offal mixed with the grain. When weevily grain is officially graded, the word "Weevily" is added to the grade designation.

Ergoty grain.—Ergot is a fungus disease that attacks cereal grains, principally rye and occasionally durum wheat and barley.

Ergot is objectionable because it discolors the flour if milled with the grain. Ergot also contains poisonous compounds that may be injurious to humans and to animals; thus foods and millfeeds manufactured from ergoty grain are undesirable.

Treated or bleached grain.—Wheat, barley, or oats that have been processed in such a way that the true quality of the grain is not deemed truly reflected by the numerical grade designation alone are considered under the official grain standards to be treated and a statement indicating the kind of treatment is added to the grade designation. Smutty wheat is sometimes processed by liming and scouring or by washing to remove the smut.

Oats and barley, if left exposed in the field to alternate rain and sunshine, become stained and weathered. These two grains are sometimes subjected to a bleaching process with sulphurous acid to remove this stained and weathered appearance and to make the grain resemble bright and well-cared-for grain. When a lot of either oats or barley has been treated by the use of sulphurous acid or any other bleaching agent, the word "Bleached" is added to the grade designation. The purpose of these notations is to inform users of such grain regarding its character.

APPARATUS NECESSARY FOR GRADING GRAIN

It is difficult to specify the grain-grading apparatus that anyone, other than a licensed grain inspector, should have available if he is to grade grain. In the Corn Belt a moisture tester is essential when the new corn crop is placed on the market, but it is not nearly so important in many of the wheat-producing areas. In the spring-wheat area of the central Northwest, equipment for removing dockage is necessary, whereas in most of the winter wheat areas there is little dockage and a full set of this equipment is not greatly needed. Flax-seed and grain sorghum sieves are needed only in rather restricted areas.

Unless wild oats, cultivated oats, or barley become mixed with wheat, a dockage tester of one of the types elsewhere described is not essential, because most of the coarse material can be removed by a hand scalper sieve ($1\frac{3}{4}$ -inch round-hole perforations), and the fine material consisting mostly of small weed seeds can be removed from the grain with the small buckwheat or the fine seed ($\frac{1}{12}$ -inch round-hole perforations) sieve. (See p. 40 for method of operation.)

The test weight per bushel of any grain is an important indication of its market value, for this test is a measure of the plumpness of the grain. It is imperative that the test-weight-per-bushel equipment be available.

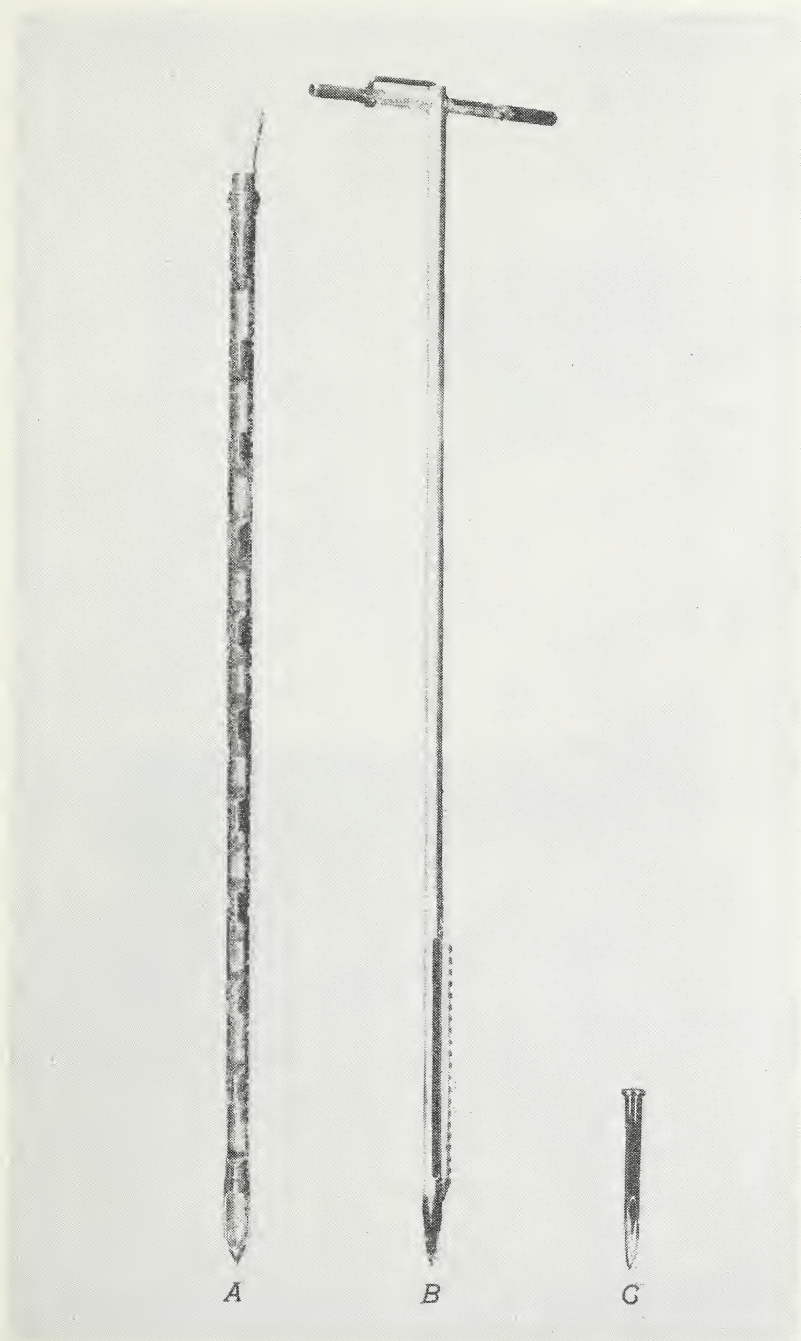
As such separations as mixtures of other grains, other classes, damaged grain, weed seeds, and other foreign matter must be weighed in the process of testing, a dependable scale or balance must be on hand.

The pieces of apparatus that are used by grain inspectors are described below.

PROBES

Representative samples should be obtained by the use of a grain probe.

The standard probe used for sampling bulk grain in cars is a double-shell slotted brass probe $62\frac{7}{8}$ inches long. Between each slot the inner shell (tube) should be separated by partitions so that each slot will be the entrance to a separate compartment (fig. 5).

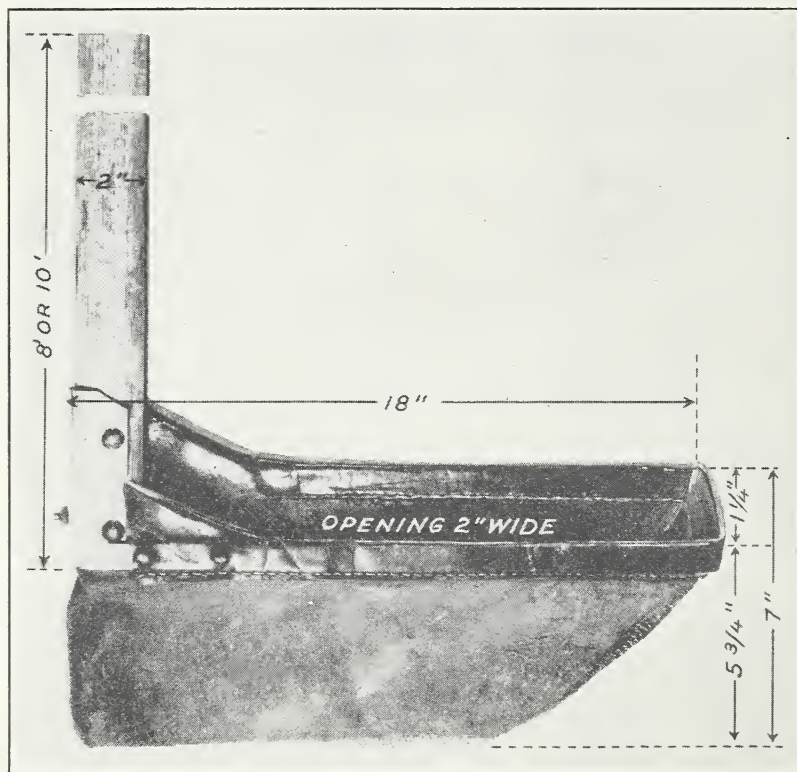


AMS 1272

FIGURE 5.—A, double-shelled compartment grain probe used for sampling bulk grain; B, a probe used for sampling ear corn in cribs; C, a small probe used for sampling sacked grain.

The ear corn probe (fig. 5) for sampling corn on the ear has been developed in recent years in connection with the commodity loan program. This apparatus consists of a tube of cold rolled steel, sharply pointed and slotted near the point. One edge of the slot bears a row of teeth for shelling the kernels from the cobs. It has an inner tube which can be turned so as to open or close the slot.

To operate, the probe is inserted into the crib of ear corn between the slats of the crib. The inner tube is then turned so as to open the slot and by means of the cross bar in the handle the whole probe is rotated so that the projecting teeth shell the kernels into the slot.



BAE 6114 B

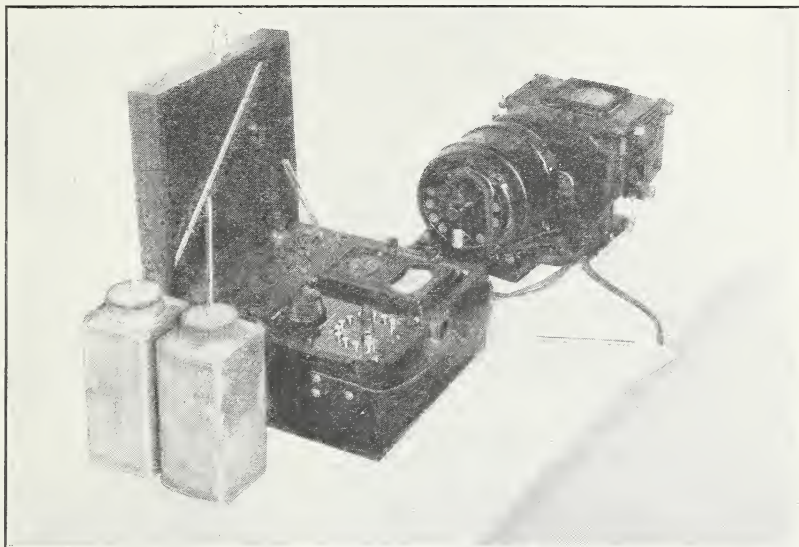
FIGURE 6.—Spout sampler (pelican) used for sampling bulk grain delivered from a spout.

SPOUT SAMPLER OR "PELICAN"

For obtaining a representative sample from a falling stream of bulk grain, and particularly for sampling bulk grain that is being spouted into the holds of a vessel, a spout sampler, generally called a pelican, is used (fig. 6). This device makes it possible to obtain complete cross sections from the stream of grain being sampled. In operation, the stream of grain is cut at frequent intervals and the samples so obtained are then reduced in size by being put through a Boerner divider (fig. 11).

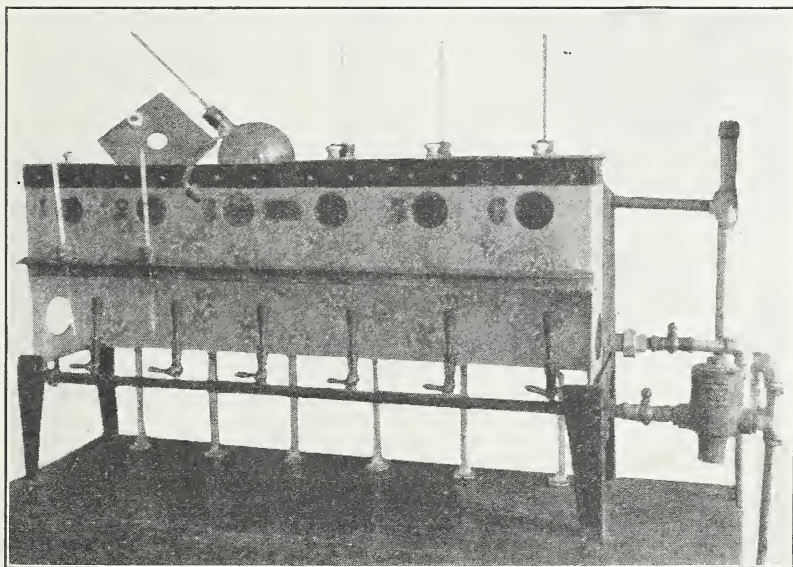
MOISTURE TESTER

The electric moisture meter and the Brown-Duvel moisture tester are the practical devices used for determining the moisture content of any grain for which standards have been established (figs. 7, 8, and 9).



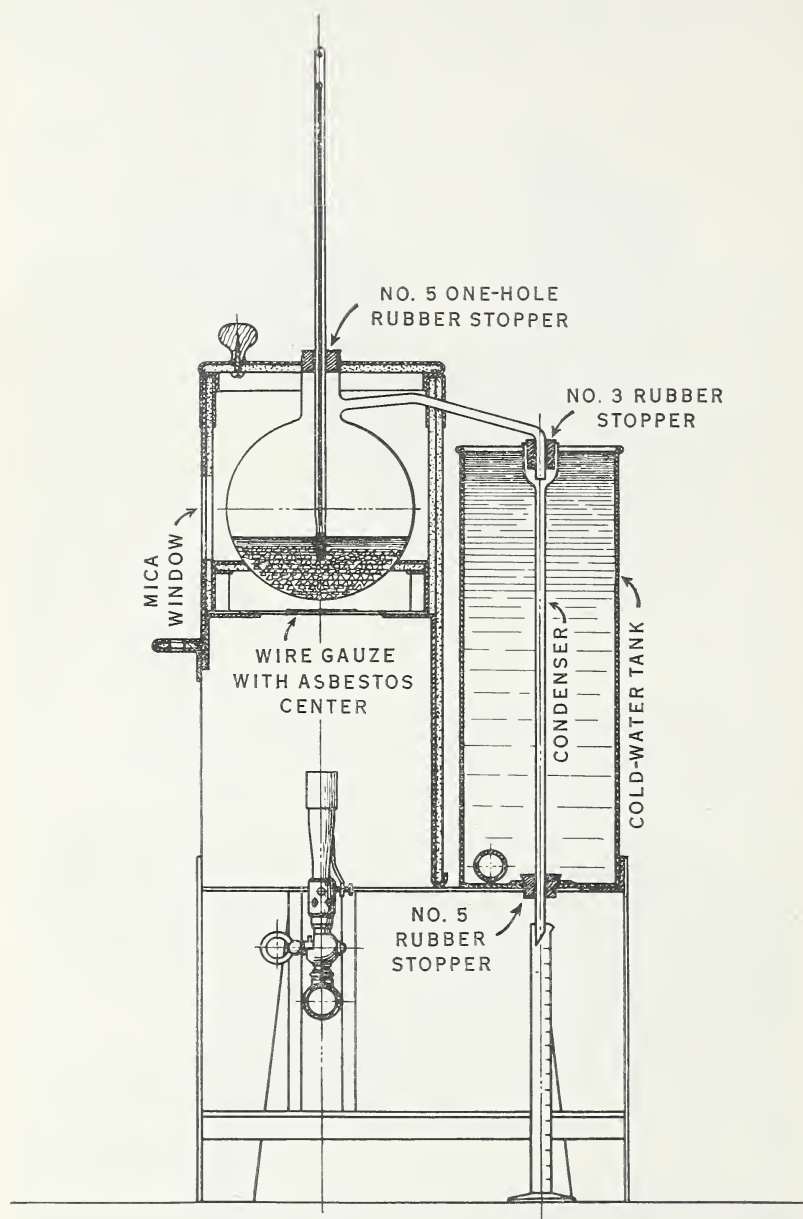
BAE 27215

FIGURE 7.—Electric moisture meter used for determining the moisture content of grain.



BAE 6996

FIGURE 8.—Six-compartment Brown-Duvel moisture tester.



BAE 10961

FIGURE 9.—Sectional view of Brown-Duvel moisture tester, showing the parts connected for use. Distillation flask is in position three-eighths of an inch above the wire gauze.

SAMPLE DIVIDER

An apparatus known as a Boerner divider (fig. 11) is used by all grain inspection offices for obtaining a thoroughly representative portion from a larger sample.

TEST-WEIGHT-PER-BUSHEL APPARATUS

Several reliable types of test-weight-per-bushel apparatus now on the market can be used for testing all grains. The official type (fig. 12) is the one described in Bulletin No. 1065. Another type is a standard bucket and beam with a funnel to regulate the flow and fall of the grain and with a special stroker (fig. 10). This type is considerably less expensive than the official type, and if the directions for its use are strictly followed, it will give results comparable with those obtained by the official tester.

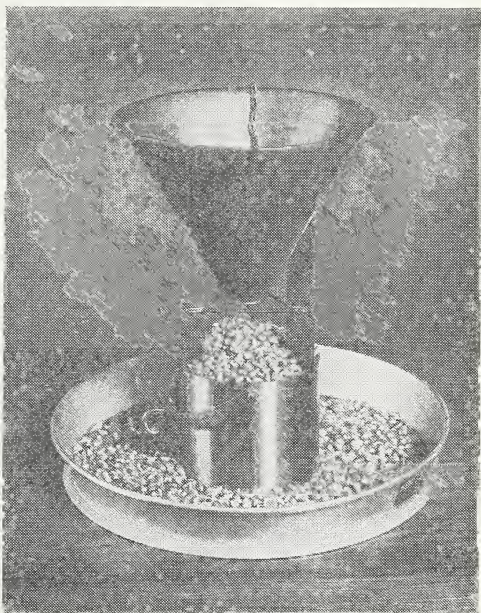
BALANCE

Large size.—For weighing all portions of grain in excess of 50 grams, a balance should be available that has a graduated beam sensitive to one-tenth of a gram and with a set of weights from 1 gram to 1,000 grams. It is used for weighing all large-sized portions of the original samples that are to be tested for dockage, moisture content, cracked corn and foreign material, and for any other determination that involves a weight of more than 50 grams (fig. 13, *B*).

Small size.—For weighing all small portions of a sample, there should be available a balance with a capacity of 50 grams with a graduated beam to read 1 gram and fractions of a gram and sensitive to one-hundredth of a gram. A set of weights from 1 gram to 50 grams should be provided for this balance (fig. 13, *A*).

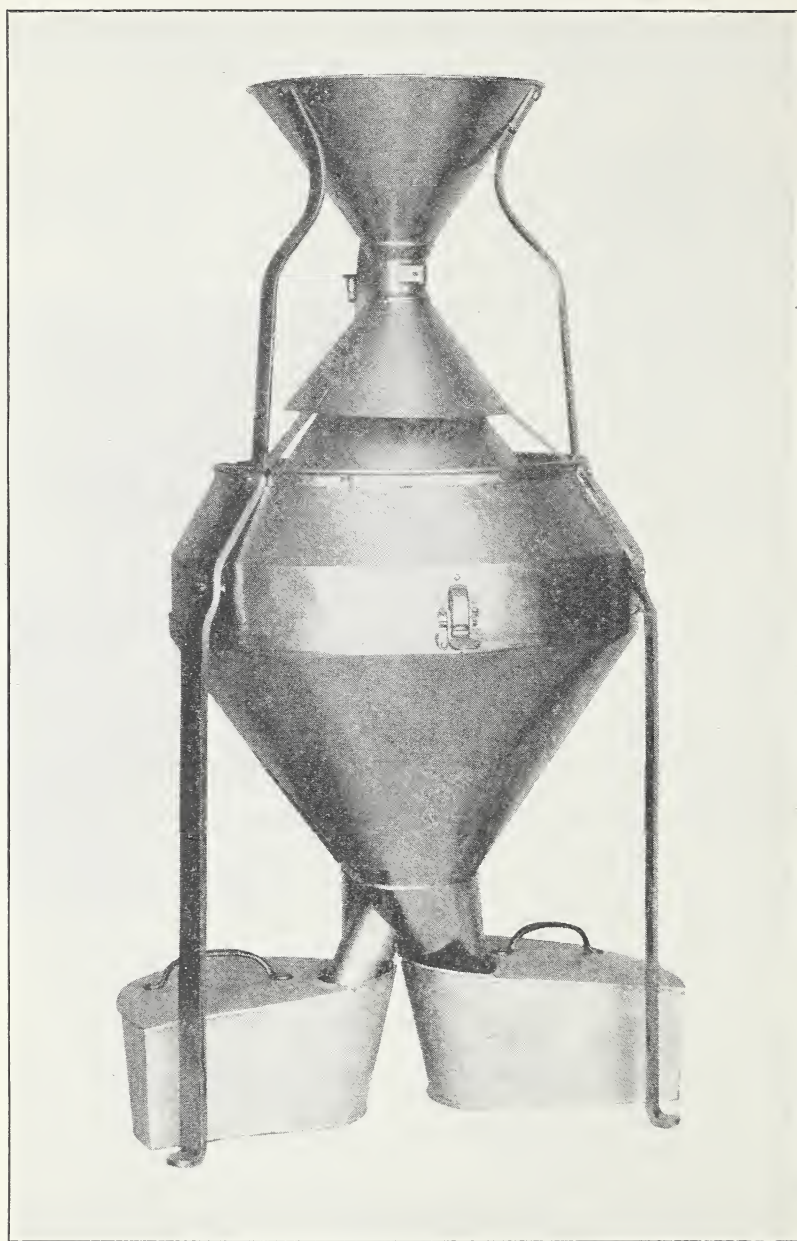
DOCKAGE TESTER

Two types of devices are in common use for removing dockage material from wheat, rye, barley, grain sorghums, and flaxseed and for the removal of cracked kernels and foreign material from corn and grain sorghums. One is the Federal dockage tester (fig. 14) used by all Federal grain supervisors and by many licensed in-



AMS 1210

FIGURE 10.—Special funnel for filling the test kettle of a simplified weight-per-bushel testing apparatus.



BAE 5295

Figure 11.—Boerner divider used for separating grain samples into representative portions.

spectors; the other is the Emerson dockage tester (fig. 15). Each is equipped with specially constructed sieves or riddles.

SIEVES

A set of standard hand sieves (fig. 16) made from 20-gage (B. & S.) metal is needed to supplement the machine sieves and riddles of the

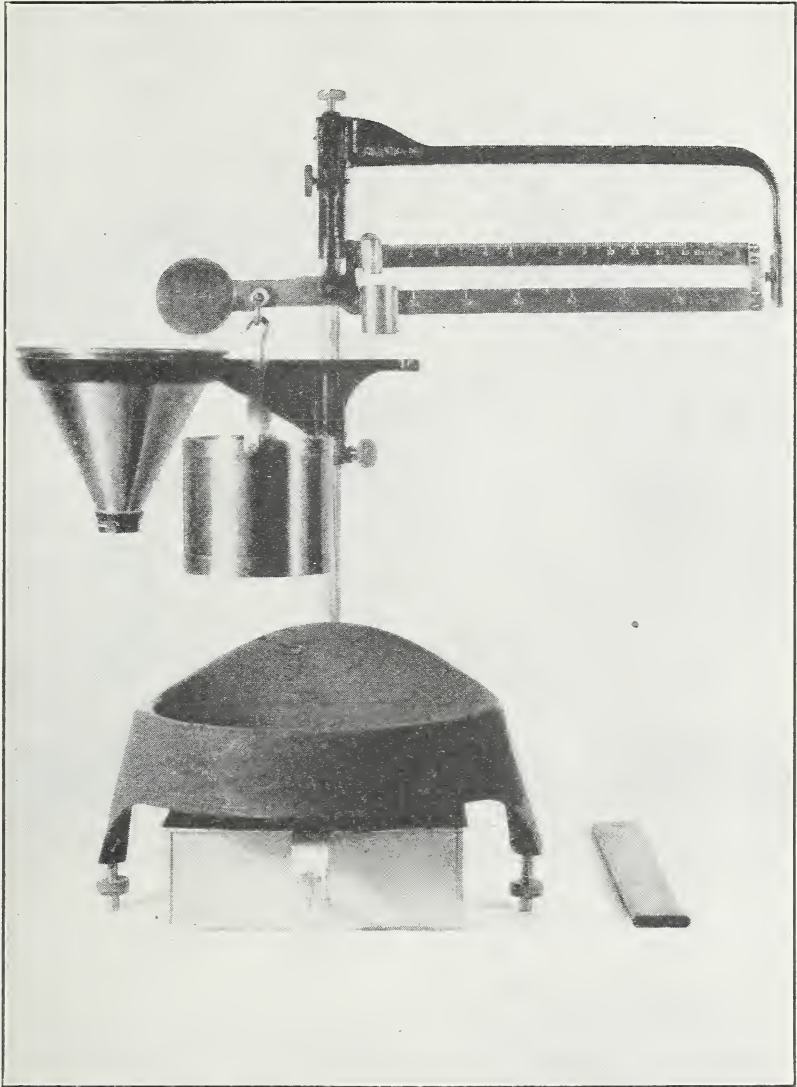


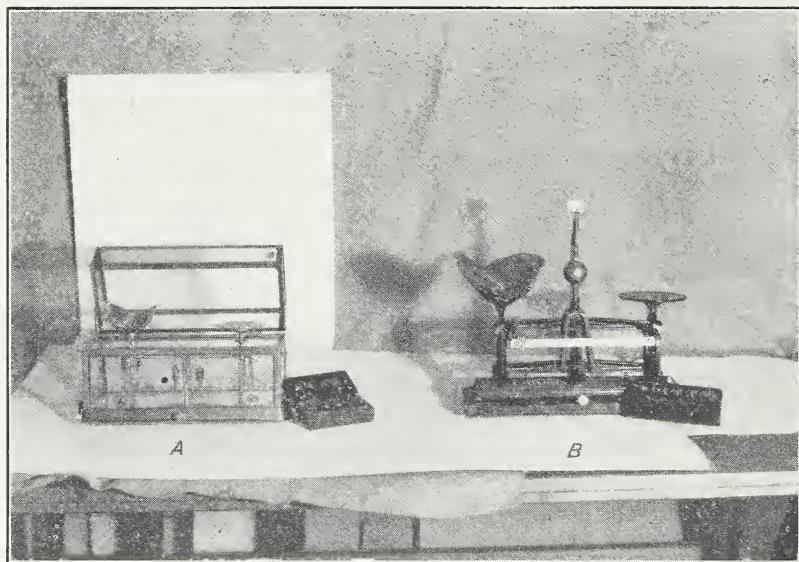
FIGURE 12.—Standard apparatus for determining the test weight per bushel of grain.

Federal dockage tester and the Emerson dockage tester. These sieves should be 13 inches in diameter and so made that they will nest freely with each other and with a bottom pan. A list of hand sieves that are sometimes used is given below. The operator need procure

only those sieves that he considers necessary for the kinds of grain that he intends to grade.

Corn sieve.—The corn sieve is perforated with round holes twelve sixty-fourths of an inch in diameter. It is used for removing cracked corn and foreign material from corn when the grader does not have either of the dockage testers heretofore mentioned. It is used also as a scalper sieve to remove coarse foreign matter from wheat and rye in the dockage determination of these grains when either of the dockage testers is not in use.

Fine seed sieve.—The fine-seed sieve has round-hole perforations one-twelfth of an inch in diameter. It is used for removing fine seeds from various grains. It may be used also for reclaiming shriveled and broken grains from fine seeds.



BAE 2974

FIGURE 13.—A, Small torsion balance, capacity 50 grams and sensitive to one-hundredth of a gram; B, large torsion balance, capacity 1,200 grams and sensitive to one-tenth of a gram.

Grain sorghums dockage sieve.—The dockage sieve for grain sorghums, with round-hole perforations two and one-half sixty-fourths of an inch in diameter, is used in making dockage determinations of grain sorghums.

Small buckwheat sieve.—The small buckwheat sieve has equilateral triangular perforations, the inscribed circles of which are five sixty-fourths of an inch in diameter. It is used for removing such seeds as wild buckwheat, pigeongrass, and seed of similar size, and as a part of the equipment for determining dockage in barley.

Small chess sieve.—The small chess sieve has slotted perforations 0.064-inch wide by $\frac{3}{8}$ -inch long. It is used for removing flaxseed from wheat, for determining the factor "thin oats" in the grading of oats, and for determining "Shrunken and/or broken kernels" in wheat.

Large chess sieve.—The large chess sieve has slotted perforations 0.070-inch wide by $\frac{1}{2}$ -inch long. It is used for removing chess seeds, quackgrass, and similarly shaped seeds from wheat.

Barley-sizing sieve.—The barley-sizing sieve has slotted perforations four and seven-eighths sixty-fourths of an inch wide by three-fourths of an inch long. It is used for removing thin barley in the determination of the subclasses Malting Barley and Barley.

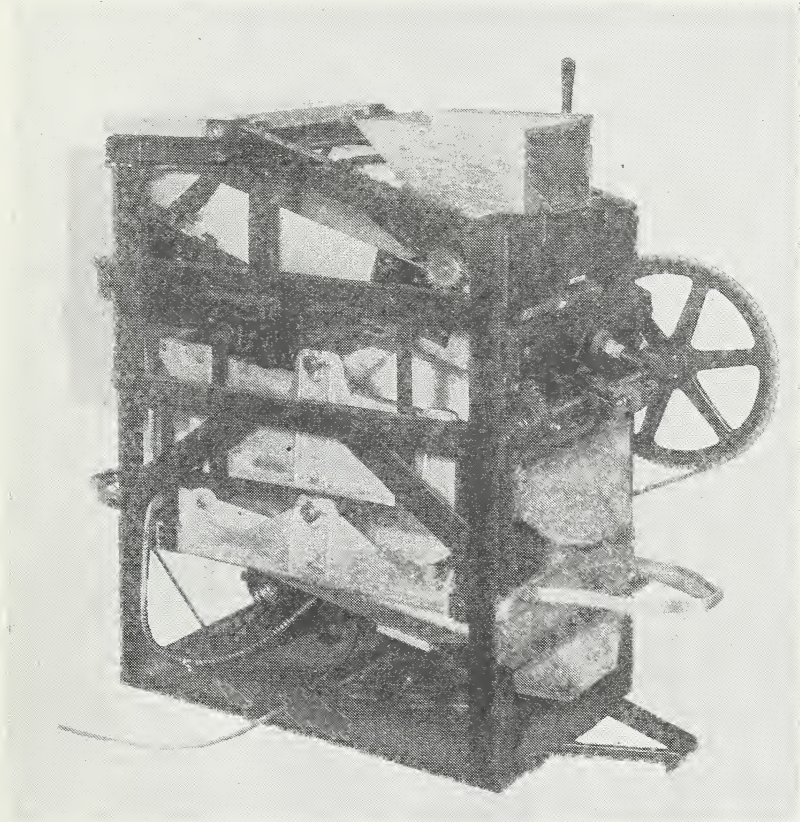


FIGURE 14.—Federal dockage tester, electrically operated.

AMS 1233

Barley scalper sieve.—The barley scalper sieve with slotted perforations nine sixty-fourths of an inch wide by three-fourths of an inch long is used in the determination of dockage in barley for removing coarse foreign material, such as corn, soybeans, sticks, and straw.

Flaxseed sieves.—One of the flaxseed sieves is perforated with round holes four and one-half sixty-fourths of an inch in diameter. This sieve is used to facilitate the removal of small seeds from flaxseed in the determination of dockage in flaxseed.

Another kind of flaxseed sieve which has slotted perforations three sixty-fourths of an inch wide by three-eighths of an inch long, is sometimes used. It is especially useful for separating cereal grains

and other coarse material from flaxseed, and may be used for removing flaxseed from wheat when determining dockage in wheat.

BARLEY PEARLER

The barley pearling machine assists inspectors to determine whether there is present a sufficient quantity of mellow (starchy) kernels in the grain to permit the barley to be graded as Malting Barley. Furthermore, the pearler is almost indispensable for detecting heat damage in barley (fig. 17).

GRAIN-GRADING METHODS

It is impracticable in this publication to enumerate all the details of how to grade samples of all the grains, because in some instances the grader must determine several factors whereas in other cases only

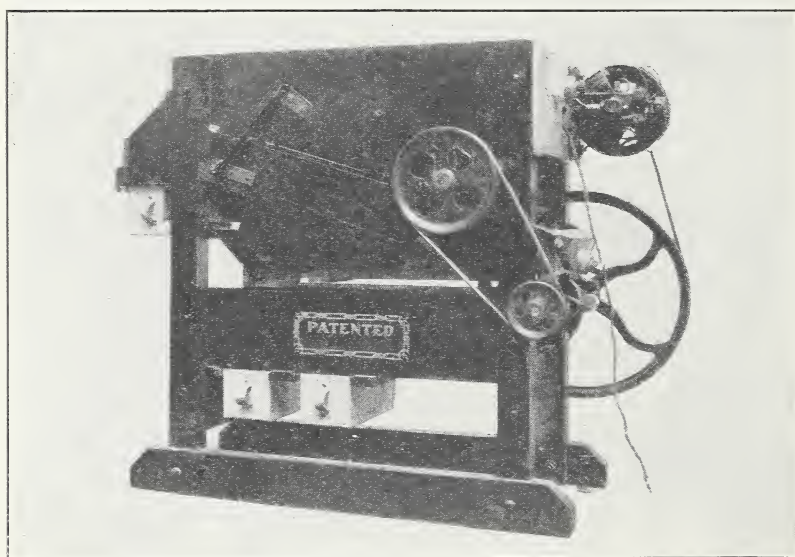


FIGURE 15.—Emerson dockage tester, electrically operated.

BAE 6211

one or two determinations may be necessary. This circumstance may be illustrated by a damp sample of pure white corn which is clean and which contains only a few damaged kernels. In this instance it is obvious that the grader need only determine the percentage of moisture to ascertain the true grade of the corn.

As a further illustration, after the dockage has been removed in grading wheat, it is frequently unnecessary to make more determinations than the weight-per-bushel test. Any additional testing or analyses made on such samples would merely furnish supplemental information without having any effect upon the grade.

In the actual grading of commercial grain the experienced grader has a great advantage over the beginner in accomplishing more and better work with less effort, because he knows from a general examination of the sample what factor or factors he should determine and what factors he may disregard. To become an efficient grader of grain

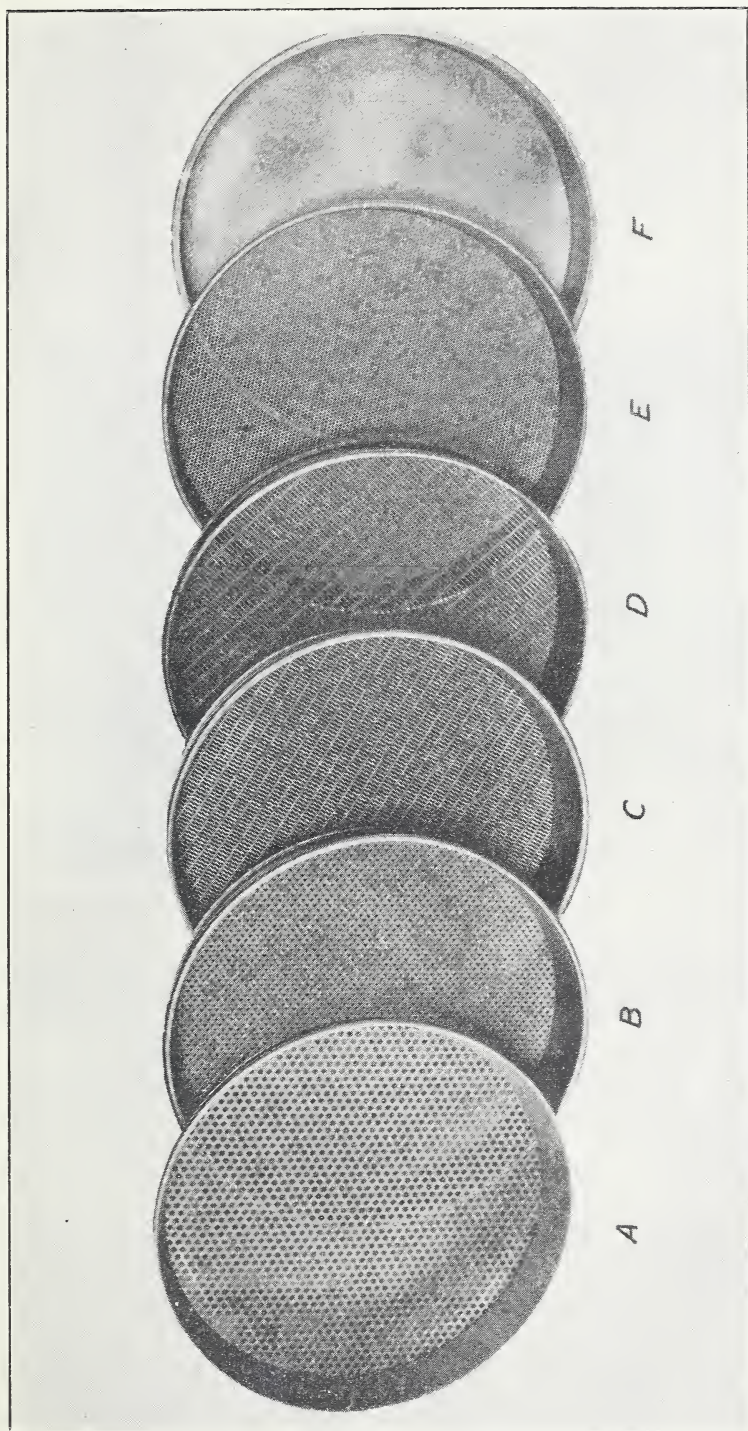
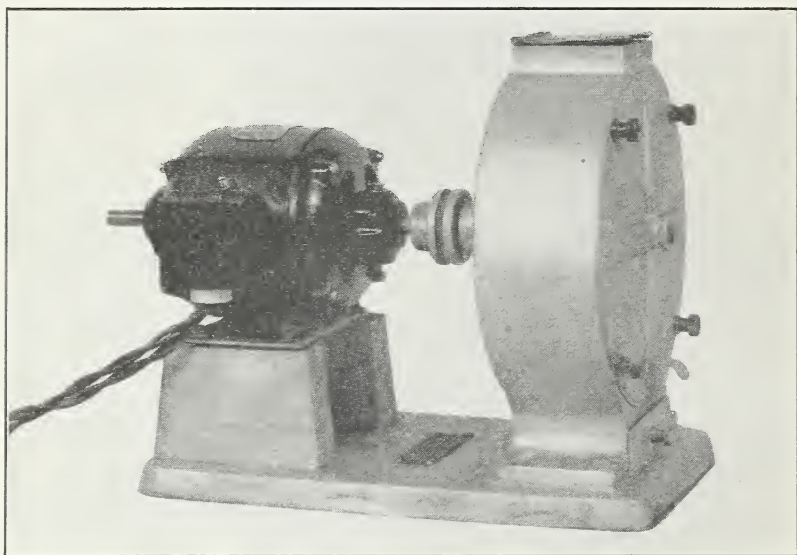


FIGURE 16.—Some of the sieves used to supplement the dockage tester in determining dockage and for removing certain kinds of foreign material from grain: *A*, Corn sieve with round-hole perforations twelve sixty-fourths of an inch in diameter; *B*, small buckwheat sieve with triangular perforations the inscribed circles of which are five sixty-fourths of an inch in diameter; *C*, small chess sieve with slotted perforations 0.064 by $\frac{1}{8}$ inch; *D*, large chess sieve with slotted perforations one-twelfth of an inch in diameter; *E*, fine-seed sieve with round-hole perforations 0.070 by $\frac{1}{2}$ inch; *F*, bottom pan.

BAE 6880

the beginner should follow an orderly procedure so that he may not overlook any of the factors that may indicate one of the lower grades.

At this point it may be well to state that in assigning the higher grades to grain, caution must be used because the factors in the higher numerical grades of all grain have much smaller tolerances than the factors in the lower grades. On the other hand, in the lower grades there is usually one outstanding factor that will degrade any given lot or parcel of grain and in such cases the other factors have no effect whatever upon the grade that is to be assigned to the grain.



BAE 27211

FIGURE 17.—Barley pearler. This apparatus removes the hulls from barley kernels, exposing the endosperm for examination.

SAMPLING GRAIN

The first essential step in grading grain is to obtain a correct and representative sample of the lot of grain to be graded. The basic instructions issued by the Department of Agriculture on this subject provide for a sample of not less than approximately 2 quarts in size.

Carlot, wagon, or truck lots.—In the case of bulk grain in a car, truck, or wagon, or in any other container in which the grain is about the same depth as in a carload, the sample is taken with a double-tube compartment trier 60 inches long (fig. 5, *A* and *B*) by probing flax-seed in seven or more places and all other kinds of grain in five or more places, well distributed in different parts of the car, truck, or other container. In the discretion of the sampler as many more probings as may be necessary are to be taken from the grain in different parts of the lot.

As each probe of grain is drawn, the grain is emptied upon a canvas for examination (fig. 18). If after examination of the separate probes, no material portion of the grain is found to be distinctly inferior to the remainder of the grain, the grain from the separate probes is combined as an average sample of the grain involved. If

the time to elapse between the drawing of the sample and the determination of grade would permit of such changes in the condition of the sample as to affect the grade, a representative portion of at least $1\frac{1}{8}$ pints of the grain should be enclosed in an airtight container. At country elevators a pail with a tight cover to hold the entire sample is often used for an airtight container.

Bins and sacks.—In the case of bulk grain in bins and warehouses where the depth of the grain is so great as not to permit thorough probing with a trier of either standard or special length, or where conditions make it hazardous for a person to enter the bin, such grain should be transferred and samples taken from a falling stream of



BAE 519

FIGURE 18.—A sampler emptying the grain from a probe upon a canvas for careful examination regarding mixtures, odors, and evenness of loading.

grain pouring into or from such bin. Samples from the falling stream are taken with a device known as a spout sampler or pelican (fig. 6) or with any other device that gives equivalent results.

In the case of grain in sacks, samples are drawn from as many individual sacks, selected at random throughout the lot, as will enable the sampler to procure a representative sample of the entire lot. The samples are taken by any approved trier of sufficient length to reach the center of the sack (fig. 5, C).

GRADING PROCEDURE

In the commercial grading of grain the lot as a whole is examined at the time of sampling for the condition factors of temperature and odor, infestation of live weevils, and any other noticeable factor not requiring a detailed analysis. When the samples are brought to the inspection office, dockage tests, weight-per-bushel tests, and moisture tests are usually made first. Further analysis is made for such grading factors as a careful examination of the sample indicates may be important. A representative portion of the sample is then taken

from either the mechanically cleaned grain or from the sample as a whole, as governed by the basis of determination of the standards, for use in making further tests.

The beginner should have a form somewhat like the one shown herewith to record his findings, based on his analyses and other observations. When the analyses are finished, the grader ascertains the grade of the grain by comparing the results of the analyses and other tests with the requirements of the standards for the kind of grain being graded.

Factor:	Identification	Test or analysis	Grade
Temperature (heating)_____		_____	_____
Odor (musty, sour, commercially objectionable foreign odors)_____		_____	_____
Weevils_____		_____	_____
Dockage_____	percent	_____	_____
Class_____		_____	_____
Subclass_____		_____	_____
Other classes_____	percent	_____	_____
Test weight_____	pounds	_____	_____
Total damaged_____	percent	_____	_____
Heat-damaged_____	do	_____	_____
Blighted_____	do	_____	_____
Foreign material_____	do	_____	_____
Matter except other grains_____	do	_____	_____
Moisture (Tough, Sample grade)_____	do	_____	_____
Garlicky (Light Garlicky, Garlicky)_____		_____	_____
Smutty (Light Smutty, Smutty)_____		_____	_____
Appearance ¹ _____		_____	_____
Special ² _____		_____	_____
Miscellaneous_____		_____	_____

¹ Appearance includes special grades for Bright, Stained, Bleached, Discolored, and Treated.

² Special includes special grades for Flint, Two-rowed, and Thin.

CLASSES AND SUBCLASSES

There is no mechanical test for determining the class to which any particular lot of grain belongs. Identification of the different classes of grain depends almost entirely upon the grader's knowledge of and familiarity with the different kinds of grain that come under his observation. Color, kernel texture, and variety characters are helpful indexes in determining the class or subclass of many of the grains.

Wheat classes.—There are seven classes of wheat, namely: Class I. Hard Red Spring Wheat; class II. Durum Wheat; class III. Red Durum Wheat; class IV. Hard Red Winter Wheat; class V. Soft Red Winter Wheat; class VI. White Wheat; and class VII. Mixed Wheat. The official standards provide that wheat of any class, except Mixed Wheat, may contain not over 10 percent of wheat of a different class or classes either singly or combined.

When gaining experience in recognizing the classes of commercial wheat, useful information may be had from variety names and time of planting. In places where proper classification of grain is difficult, it will be helpful to the beginner to obtain samples of the different classes of such grain from reliable sources that can vouch for the class. In Department Circular 424, there is a list of commercial varieties of wheat grown in the United States, by classes, and in the order of their estimated acreage in 1934. It is practicable here to give only the most important varieties.

Hard Red Spring: Thatcher, Marquis, Ceres, Supreme, Progress, Marquillo, Reward, Hope, Pilot, and Rival.

Durum: Kubanka, Mindum, Monad, Acme, Nodak, Kahla, Arnautka, and Peliss.

Red Durum: Red Durum (synonyms: D-5, Durum No. 5, D-Fife, Ladd Durum, Resistant Fife, Rust Proof).

Hard Red Winter: Turkey, Blackhull, Kanred, Tenmarq, Nebraska No. 60, Nebred, Cheyenne, Ridit, Michikof, Iobred, Minturki, Karmont, Montana No. 36, and Newturk.

Soft Red Winter: Fultz, Fulcaster, Trumbull, Red May, Leap, Poole, Mediterranean, Currell, Nittany, Harvest Queen, Clarkan, Thorne, Baldrock, and Purplestraw.

White: Goldcoin, Baart, Federation, Rex, and Florence, (Quality).

In the inspection procedure for determining class in wheat, the dockage is first removed (see p. 39 for method) and then a representative portion, of approximately 25 grams, is weighed. Any kernels that are distinctly of another class are separated from the predominating class, and the percentage of other classes is determined by weight. In addition to the limitation of 10 percent of wheats of other classes in all classes except Mixed Wheat, there are special numerical grade-limitations for wheat of other classes for all of the classes of wheat except Mixed and Red Durum. The experienced grader makes this latter determination with the same separation described in this paragraph.

Hard Red Winter and Hard Red Spring subclasses.—A representative portion of approximately 25 grams of the dockage-free wheat is taken in determining subclass. In hard red winter and in hard red spring wheat the kernels are separated into dark, hard, and vitreous kernels and the kernels that are not dark, hard, and vitreous. Any wheat kernels that are starchy or that have any starchy spots are not considered to be dark, hard, and vitreous kernels.

Durum subclasses.—To decide the subclass to which any lot of common durum wheat belongs, a 25-gram portion of the dockage-free wheat is taken and analyzed for texture. In making the separation any kernel that is not amber in color or any kernel that is starchy or that has a starchy spot on it is not considered to be "hard and vitreous and of amber color."

Red Durum.—There are no subclasses of Red Durum.

Amber Mixed Durum and Mixed Durum.—The standards for Mixed Wheat provide for two special classifications known as Amber Mixed Durum and Mixed Durum. In both of these classifications there are special limitations for wheat other than Durum and especially for Red Durum, White, and Soft Red Winter Wheats. These classifications provide for the superior mixtures of Durum with other classes of wheat.

Soft Red Winter subclasses.—Soft Red Winter Wheat grown west of the Great Plains region is included in the subclass Western Red. All other soft red winter wheats containing not in excess of 10 percent of Western Red are included in the subclass Red Winter.

White Wheat subclasses.—The class White Wheat is divided into four subclasses. (See Handbook.) For determining the subclass of White Wheat, the wheat in some cases is analyzed on the basis of texture and in other cases on the basis of variety characteristics.

The texture requirements for all the subclasses of the above classes of wheat, and the special limitations of certain variety types in sub-

classes, are given under the respective wheat classes in the Handbook of Official Grain Standards.

Rye.—There is only one class of rye and there are no subclasses.

Oat classes.—Oats are divided into five classes as follows: Class I, White Oats; class II, Red Oats; class III, Gray Oats; class IV, Black Oats; and class V, Mixed Oats. For the purpose of this classification, the specifications for each class are based on color characteristics; White Oats shall include yellow oats; and tinges of white, brown, or black, on the kernels of any red oats variety shall not affect their classification as Red Oats.

Barley classes.—Barley is divided into four classes, as follows: Class I, Barley; class II, Black Barley; class III, Western Barley; and class IV, Mixed Barley. There are no standards for hull-less barley.

Barley subclasses.—Barley (class I) includes the white (glumes) barley grown east of the Rocky Mountains and is the only class of barley that is divided in subclasses, namely: (A) Malting Barley, and (B) Barley.

Subclass Malting Barley.—The specifications of the Malting Barley subclass limit the admixture of certain kinds of barley which are considered undesirable in barley intended for the malting process. All of the specifications in the malting subclass are based on the sample after the removal of dockage and in some cases after pearling. The full requirements for the subclasses are given in the Handbook of Official Grain Standards. The inspection procedure for making the determinations for the subclass Malting Barley are given below.

Sizing to determine Malting Barley.—The subclass Malting Barley may not contain more than 15 percent of barley or other matter that will pass through a 20-gage metal sieve with slotted perforations 0.076 ($4\frac{7}{8}/64$) of an inch wide by three-fourths of an inch long. In making the sieving test for Malting Barley, a representative portion of approximately $1\frac{1}{8}$ quarts of the dockage-free barley is sieved with a hand sieve having perforations as described above. In sizing, the sieve is held level and so that the grain will move lengthwise of the slots. The barley is then moved 30 times (left to right and return) from side to side across the sieve in a steady manner, with not more than one-third of the portion being tested on the sieve at any one time. All barley and other material that passes through the slotted sieve is then weighed and the percentage is computed. If the thin barley and foreign material that pass through the sieve are not in excess of 15 percent the barley is classified as Malting Barley insofar as this determination applies.

Testing for mellow barley kernels.—The standards provide that Malting Barley shall contain 75 percent or more of mellow barley kernels which kernels are not semisteely as a whole. Mellowness has reference to starchiness. To determine the percentage of mellow barley in any parcel of barley of the class Barley, a portion of approximately 50 grams of the dockage-free barley should be placed in a pearling machine (fig. 17) and be subjected to the pearling process for about 3 minutes. The pearled barley is then freed from dust and hulls by being sieved, after which the pearled kernels are weighed. All the white and gray-colored kernels that appear to be 10 or more percent starchy in texture are classified as mellow kernels.

All pearly kernels ranging in color from a distinct tinge to a pronounced shade of green or blue and which appear to be 50 percent or more starchy in texture are also classified as mellow kernels. On the basis of the weight of the pearly kernels (not the weight of the original sample before being pearly) the percentage of mellow kernels is computed.

Skinned and broken barley.—The standards for barley provide a 5-percent maximum limit of skinned and broken kernels in the subclass Malting Barley, but provide more lenient maximum grade limits for broken kernels only in the subclass Barley and in the other classes of barley. (See Handbook of Official Grain Standards.) A skinned kernel of barley is any kernel of barley that has at least one-third of the husk removed, or which has the husk loosened or removed over the germ. A broken kernel of barley is one that is broken, regardless of the extent or the size of the pieces. A portion of approximately 30 grams of the dockage-free barley is used for making this determination. In the grading of Malting Barley, the skinned and broken kernels, separated by hand from the sample being tested, are weighed and the percentage is computed.

Damaged barley.—Damaged barley consists of kernels and pieces of kernels of barley which are damaged or materially discolored by blight and/or mold, or which are heat-damaged, sprouted, frosted, badly ground-damaged, badly weather-damaged, or otherwise materially damaged. The official standards for barley provide a 4-percent limit of damaged barley in the grades for Malting Barley. To determine the percentage of damaged barley a 30-gram portion of dockage-free barley is analyzed.

Unsuitable malting types.—The standards allow a tolerance of 5 percent of two-rowed and/or other types or varieties of barley of unsuitable Malting type such as Trebi and Black, in the subclass Malting Barley. To determine the percentage of such barley approximately 30 grams of dockage-free barley are analyzed and the percentage is computed.

Other subclass requirements for Malting Barley.—In addition to the foregoing requirements, Malting Barley must meet the requirements of the numerical grades Nos. 1 to 3, inclusive, of the class Barley. Bleached barley is excluded from the Malting Barley subclass.

Determination of grain sorghums classes and subclasses.—There are five classes of grain sorghums, all of which are based on color. Subclasses are provided for the classes White, Yellow, and Red. The most important of these subclasses are based on kernel types. The determinations for class and subclass are made on the basis of not less than a 25-gram portion of the grain when free from dockage and when free from that part of the "cracked kernels, foreign material, and other grains" which can be removed readily by the use of the small buckwheat sieve. If there appear to be mixtures of different grain sorghums present the above portion is separated into its component parts and the separations are weighed and the percentage of each computed.

Determination of class in corn.—There are three classes of corn based entirely upon color, namely, class I, Yellow Corn; class II, White Corn; and class III, Mixed Corn. A slight tinge of red on otherwise yellow kernels does not affect their classification as Yellow

Corn, nor does a slight tinge of light straw color or of pink on kernels that are otherwise white affect their classification as White Corn. Kernels that are deep red, blue, striped, or variegated in color are considered as being neither yellow nor white, and are therefore classified as Mixed Corn. A mixture of more than 5 percent of kernels other than yellow in Yellow Corn, and a mixture of more than 2 percent of kernels other than white in White Corn, causes the corn to be classified as Mixed Corn.

To make the test for color in the determination for class of corn a representative portion of not less than 250 grams from which the cracked corn and foreign material has been separated, is used.

SPECIAL GRADE DESIGNATIONS

Special grade designations are added to and made a part of the grade designation to indicate qualities that cannot be expressed by the numerical grades alone. A list of the special grades and the standards in which they occur is given in table 2. The grains that are graded on a dockage system are indicated at the bottom of the table. As provided in the basis of grade determinations in the official standards, the analysis of the sample for the purpose of applying a special grade is based upon the sample as a whole, or upon the grain when free from dockage or in the case of corn upon the grain after the removal of cracked corn and foreign material. The three bases of determinations are indicated respectively in the table by the letters W, D, and F.

TABLE 2.—*Special grade designations in the standards for the various grains*

Special grade designation	Grain and basis of determination ¹								
	Wheat	Corn	Barley	Oats	Feed Oats and Mixed Feed Oats	Rye	Grain sorghums	Flaxseed	Mixed Grain
Re appearance:									
Bleached			D	W	W				
Bright			² D	W			W		
Discolored							W		
Stained			² D						
Treated	D								W
Re garlic bulblets:									
Light Garlicky	W			W		W			
Garlicky	W		W	W		W			W
Re smut:									
Light Smutty	³ D					³ D			
Smutty	³ D		D	W	W	³ D	W		W
Smut dockage (optional method)	D								
Re test weight:									
Extra Heavy				W					
Heavy				W					
Test weight of Western Barley			² D						
Re other factors:									
Blighted			D						W
Ergoty	D		D	W	W	D			W
Flint		F							
Flint and Dent		F							
Thin				W					
Tough	D		D	W	W	D			W
2-rowed			D						
Weevily	W	W	W	W	W	W	W		W
Dockage system applied	W		W			W	W	W	

¹ W, The special grade is determined upon the grain as a whole. D, The special grade is determined upon the basis of the grain when free from dockage. F, The special grade is determined upon the basis of the grain after the removal of the cracked corn and foreign material.

² The special grade in barley applies to Western Barley only.

³ The odor of smut is determined upon the grain as a whole.

Tough grain.—The special grade designation “Tough” applies to the standards for wheat, barley, oats, Feed Oats, Mixed Feed Oats, rye, and Mixed Grain. The minimum and maximum moisture limits for tough grain of the various grains are shown in table 3. When the moisture content exceeds the maximum percentage allowed in the special grade “Tough,” the grain is then graded “Sample grade.”

An example of the use of the special grade designation “Tough” is as follows: No. 2 White Oats. Tough. The designation “Tough” does not apply in the case of corn, grain sorghums, or flaxseed.

TABLE 3.—*Minimum and maximum moisture limits for tough grain*

Grain	Moisture content of tough grain	
	In excess of—	Not to exceed—
	<i>Percent</i>	<i>Percent</i>
Wheat:		
Hard Red Winter, Soft Red Winter, and White	14	15.5
Hard Red Spring, Durum, and Red Durum	14.5	16
Barley:		
Barley (class 1) and Black Barley	14.5	16
Western Barley	13.5	15
Oats, Feed Oats, and Mixed Feed Oats	14.5	16
Rye	14	16
Mixed Grain	14.5	16

Smutty wheat.—Any wheat which before the removal of dockage has an unmistakable odor of smut or which after the removal of dockage contains balls, portions of balls, or spores of smut, in excess of a quantity equal to 14 balls of average size in 250 grams of wheat, is classified as smutty wheat.

The standards provide two optional methods for grading Smutty Wheat.

(1) **Smut dockage:** (This method is used in the far Western States.) If the wheat is smutty, a 500-gram portion of the dockage-free wheat is placed in a laboratory wheat scouter where the smut is removed. The loss in weight of the wheat (not the weight of the smut removed) that is caused by this removal of the smut is computed in terms of percentage based on the total weight of the grain when free from dockage. The percentage of smut dockage thus computed is stated in terms of half percent, whole percent, or whole-and-a-half percent, as the case may be. The percentage of smut dockage so calculated and stated is added to the grade designation preceding the statement of dockage, if any. Any fraction of a percent less than one-half percent is disregarded.

(2) **Light Smutty and Smutty:** (This method is in general use east of the Rocky Mountains.) In the case of wheat, which before the removal of dockage has an unmistakable odor of smut, or which after the removal of dockage contains balls, portions of balls, or spores of smut, in excess of a quantity equal to 14 balls but not in excess of a quantity equal to 30 balls of average size in 250 grams of wheat, the term “Light Smutty” is added to, and made a part of, the grade designation.

In case smut balls are present in excess of a quantity equal to 30 balls of average size in 250 grams of wheat, the designation "Smutty" is added to, and made a part of, the grade designation.

Smutty rye, barley, oats, and grain sorghums.—Special grades for smutty rye, smutty barley, smutty oats, and smutty grain sorghums apply when the smut present exceeds the limitations specified in the definitions for smutty in these grains.

Garlicky wheat.—Garlicky wheat is wheat that contains two or more green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets in 1,000 grams of wheat before the removal of dockage. Three dry garlic bulblets are considered equivalent to one green garlic bulblet. Not less than 1,000 grams of grain are used for making this determination.

(1) In case there are two or more, but not more than six, green garlic bulblets, or an equivalent quantity of dry or partly dry bulblets per 1,000 grams of wheat, the wheat is classified as "Light Garlicky," and this term is added to, and made a part of, the grade designation.

(2) In case there are more than six green garlic bulblets or an equivalent quantity of dry or partly dry bulblets per 1,000 grams of wheat, the wheat is classified as "Garlicky" and this term is added to, and made a part of, the grade designation.

Garlicky rye, barley, oats, and Mixed Grain.—Special grades for garlicky rye, garlicky barley, garlicky oats, and garlicky Mixed Grain apply to these grains when the garlic present exceeds the limitations provided in the garlicky definitions for such grain. (See Handbook of Official Grain Standards.)

Weevily grain.—The official grain standards provide that any grain infested with live weevils or other insects injurious to stored grain must be given the special grade designation "Weevily."

For the purposes of the standards, "live weevils" include the rice weevil, the granary weevil, and the lesser grain borer; "other insects" injurious to stored grain include beetles, moths, and mealworms; all of which, together with other "live weevils" and "other insects injurious to stored grain" are described in Farmers' Bulletin No. 1260.

In the application of the grain standards, grain is considered to be infested with live weevils and/or other insects injurious to stored grain when there are present in a 1,000-gram portion of any grain (as taken from the bulk) the number of live weevils and/or other insects listed below:

Wheat and rye: Two or more live weevils, or one live weevil and two or more other insects, or five other insects alone.

Barley, oats, Feed Oats, Mixed Feed Oats, grain sorghums, and corn: Two or more live weevils, or 1 live weevil and 10 or more other insects, or 25 or more other insects alone.³

Whenever any of the above-mentioned grains are classified as Weevily the word "Weevily" is added to, and made a part of, the grade designation.

Special grades for ergoty grain.—Any dockage-free wheat, rye, or barley, as well as any oats, Feed Oats, Mixed Feed Oats, and Mixed

³ When a considerable number of live Angoumois moths are noted on top of the grain in a railroad car or other container, their presence, for the purposes of determining the special grades for Weevily grain, is evidence of infestation.

Grain (with all of the foreign material included in the last four grains) which contains more than 0.3 percent of ergot is classified as Ergoty, and the word "Ergoty" must be added to, and made a part of, the grade designation. The regulations for the enforcement of the Food and Drugs Act provide that any flour or other manufactured cereal product that contains more than 0.1 percent of ergot shall be considered to be adulterated. Consequently, as much as possible of the ergot should be removed from grain that contains ergot before the grain is converted into flour or feed.

Determining percentage of ergot in wheat, rye, or barley.—To determine the percentage of ergot in either wheat, rye, or barley, a representative portion of at least 250 grams should be taken from the dockage-free grain.

The ergot is picked out by hand and weighed, and the percentage of ergot is computed on the basis of the portion analyzed.

Determining percentage of ergot in oats, Feed Oats, Mixed Feed Oats, or Mixed Grain.—To determine the percentage of ergot in oats, Feed Oats, Mixed Feed Oats, or Mixed Grain, a representative portion of at least 250 grams should be taken from the original sample (all foreign material included). The ergot is picked out by hand and weighed, and the percentage of ergot is computed on the basis of the portion analyzed.

Sizing to determine thin oats.—Thin oats are any oats, whether sized, clipped, or natural which contain more than 20 percent of oats and/or other matter except "fine seeds" that will pass through a 20-gage metal sieve perforated with slots 0.064 inch wide by $\frac{3}{8}$ inch long (small chess sieve).

The test for "thin" oats is made by hand-sieving a representative portion of the original sample. Approximately $1\frac{1}{8}$ quarts of oats should be used but not more than one-third of this portion should be on the sieve at any one time. The sieve is held level and shaken in a steady manner 20 times (left to right and return) in such a way that the oats move lengthwise of the slots. The material that passes through the sieve in this operation is resieved over the small buckwheat hand sieve (p. 43) to remove the "fine seeds." The small undersized oats that passed through the small chess sieve and from which the fine seeds have been removed are then weighed and the percentage of thin oats is computed on the basis of the weight of the portion that was tested. An example for the use of this special grade designation is No. 2 White Oats, Thin.

Test weight of Western Barley.—Test weight per bushel is not a grading factor for determining the numerical grade of Western Barley. (See Handbook of Official Grain Standards.) Instead, the test weight per bushel is added to, and made a part of, the grade designation, following the name of the class. The test weight is expressed in terms of whole pounds, and a fraction of a pound is disregarded. An example of this special grade designation is No. 3 Western Barley, 45 pounds.

Extra Heavy Oats (all classes).—Any oats that have a test weight of 38 pounds or more per bushel are graded as Extra Heavy and this term is added to, and made a part of, the grade designation. An example of this special grade designation is No. 2 Extra Heavy White Oats.

Heavy oats (all classes).—Any oats that have a test weight of 35 pounds or more per bushel but less than 38 pounds are graded as Heavy and this term is added to, and made a part of, the grade designation. An example of this special grade designation is No. 2 Heavy White Oats.

Heavy Hard Red Spring Wheat.—The designation "Heavy" is not set up specifically as a special grade in the standards for hard red spring wheat, but specifications concerning it are included in the tabulated parts of the standards. For any wheat of the subclasses Dark Northern Spring, Northern Spring, and Red Spring of the class Hard Red Spring which grades No. 1 and which has a test weight per bushel of 60 pounds or more, the word "Heavy" is added to the grade designation preceding the name of the subclass. An example of this grade is No. 1 Heavy Dark Northern Spring.

Bright Oats.—Oats of good natural color, excepting bleached oats, are graded as Bright. For this determination the whole sample is used, and as there is no mechanical test for this factor, the decision of whether or not the oats are Bright rests entirely upon the grader's judgment. In actual practice, licensed grain inspectors are guided in their decisions by instructions and types issued by the United States Department of Agriculture. For oats that are graded Bright the word "Bright" is added to, and made a part of, the grade designation, with the word "Bright" preceding the name of the class. An example of the use of this term is No. 1 Bright White Oats.

Bright Grain Sorghums and Bright Western Barley.—The special grade Bright is also provided for grain sorghums and for Western Barley.

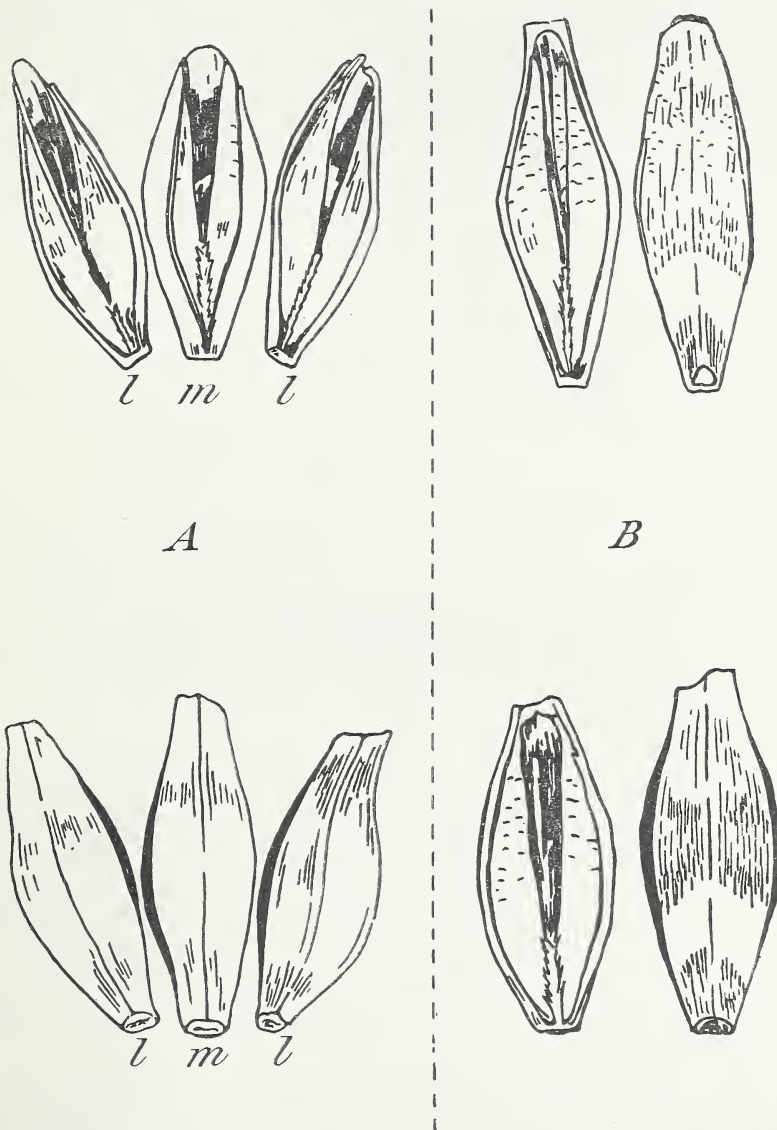
Stained Western Barley.—Any Western Barley (excepting Bleached Barley) that is badly stained or weathered is graded as Stained, and when such barley is so graded the word "Stained" is added to, and made a part of, the grade designation, as, for example, No. 2 Western Barley, Stained.

Discolored Grain Sorghums.—Grain Sorghums that are discolored but that are not badly weathered are graded as Discolored and the word "Discolored" is added to, and made a part of, the grade designation, as, for example, No. 2 White Kafir, Discolored. (Badly weathered grain sorghums are graded Sample grade.)

Blighted Barley.—The damage commonly referred to as scab or blight in barley is caused by minute fungus parasites of several known kinds which attack barley. The blighted barley kernels are discolored black, pink, or reddish brown. Barley that is badly blight infected is often light in test weight per bushel. For determining the percentage of blighted kernels in a sample of barley, a portion of not less than 30 grams of the dockage-free barley is analyzed. When more than 4 percent of the barley is blight-damaged, the word "Blighted" is added to, and made a part of, the grade designation. Any barley in grade No. 1 of the class Barley or of the class Black Barley that does not come within the provisions of the special grade Blighted may contain not more than 2 percent of blight-damaged barley.

Two-rowed Barley.—Two-rowed barley consists of two-rowed barley of the subclass Barley, of the class Barley, or of the class Western Barley, and may not contain more than 10 percent of barley other

than two-rowed varieties. In threshed grain, two-rowed barley is indicated by the absence of six-rowed lateral kernels which have curved sides as illustrated in figure 19. To determine the percentage



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FIGURE 19.—A, Six-rowed barley; *l*, lateral kernels; *m*, middle kernels. B, Two-rowed barley; no lateral kernels.

of two-rowed barley in any sample, approximately 30 grams of the dockage-free barley are analyzed and if the barley does not contain more than 10 percent of barley varieties other than two-rowed, the word "Two-rowed" is added to, and made a part of, the grade design-

nation, preceding the name of the class or subclass, as the case may be. An example of this special grade designation is No. 1, Two-rowed Barley.

Flint Corn.—The greater part of the corn in commerce is the dent type, but recently some flint types of corn have been placed on the market. The official grain standards for corn define Flint Corn as corn of any class that consists of 95 percent or more of corn of any of the flint varieties. An example of special grade designation for flint corn is No. 1 Yellow Corn, Flint.

Flint and Dent Corn.—Flint and Dent Corn is defined in the standards as corn of any class which consists of a mixture of the flint and dent varieties and which contains more than 5 percent but less than 95 percent of corn of any of the flint varieties. An example of a special grade designation for such corn is No. 3 White Corn, Flint and Dent.

To determine the percentage of flint corn in a sample, a representative portion of approximately 250 grams of the sample from which the cracked corn and foreign material has been previously removed should be analyzed for flint and dent kernels. The separation of the flint corn is then weighed and the percentage computed.

MOISTURE TESTING

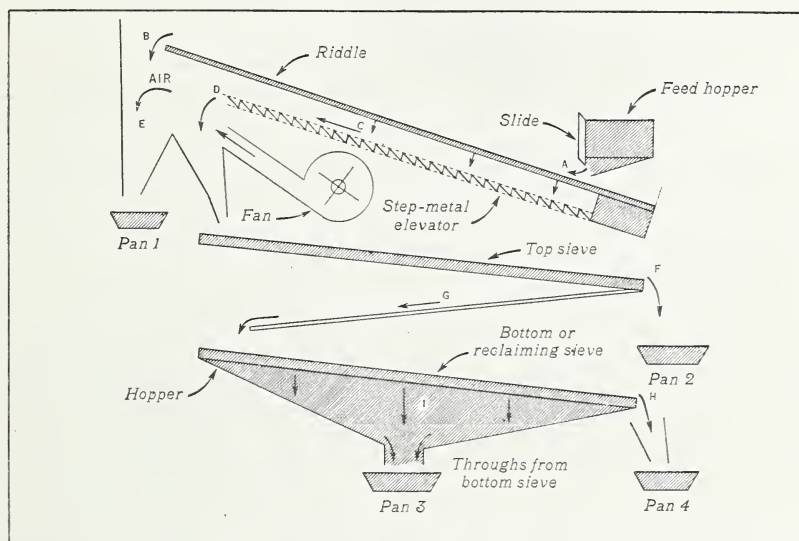
The water oven is specified in the official grain standards as the official tester for determining the percentage of moisture in corn, and the air oven is specified as the official tester for determining the moisture content in all of the other grains. In practice, however, the moisture content of any grain may be found by any device and method for ascertaining the percentage of moisture that will give results equivalent to those obtained by the water- or air-oven tests. Two types of moisture testers in use give quicker results than can be obtained by either oven test.

Electric moisture meter.—One of the rapid testers is an electric moisture meter (fig. 7). It is used by all Federal grain supervisors and also by a large majority of the licensed grain inspectors throughout the United States. To make a moisture test with this apparatus not less than 150 grams of "small grain" or 250 grams of corn are passed between two roller electrodes. The meter measures the electrical resistance of the grain as it passes between these electrodes. Tables and complete instructions for converting the electrical resistances into terms of percentages of moisture are given in the latest revised edition of the Handbook of Instructions for the Installation and Operation of the Tag-Heppenstall Moisture Meter (mimeographed).

Brown-Duvel moisture tester.—The other type of rapid tester is the Brown-Duvel moisture tester (figs. 8 and 9). To determine the moisture content of grain with this tester, 100 grams of grain are mixed with 150 cubic centimeters of suitable engine oil in a distillation flask. Heat is then applied and the water is distilled into a graduated cylinder to determine the percentage quantity of moisture in the grain. For further details regarding the operation of this tester, the reader should refer to a copy of Department Bulletin No. 1375, revised.

DOCKAGE TESTING

The Federal standards for wheat, rye, barley, flaxseed, and grain sorghums, provide for a determination of dockage. Dockage in wheat, rye, and barley may be defined as the foreign material in any of these grains which can be removed readily by appropriate sieves and cleaning devices, and undeveloped, shriveled, and small pieces of grain removed in properly separating the foreign material which cannot be recovered by proper rescreening or recleaning. Dockage in flaxseed, however, includes all foreign material in the sample. In the case of grain sorghums, the dockage consists only of the material that will pass through a prescribed sieve.



BAE 34329

FIGURE 20.—Operations performed by Federal dockage tester on samples of wheat: A, Sample being discharged from hopper onto riddle; B, tailings (coarse dockage) discharged from riddle, drops into pan 1; C, grain that passed through riddle being elevated by step metal elevator; D, grain dropping through air blast; E, material removed from grain by air blast, drops into pan 1; F, cleaned grain, "overs" from top sieve, drops into pan 2; G, "throughs" from top sieve drop to return slide, which directs material to high end of bottom sieve; H, grain reclaimed over bottom sieve, drops into pan 4; I, material through bottom sieve, fine dockage drops into pan 3.

A machine known as the Federal dockage tester is used in the determination of dockage and in certain cases the cleaning operation of this machine is supplemented by the use of hand sieves (fig. 20). A second machine known as the Emerson dockage tester is used where the Federal dockage tester is not available. Both machines employ step-metal riddles for removing coarse dockage and sieves for removing weed seeds, dirt, and finely broken pieces of grain. Complete instructions for the use of these two dockage machines may be obtained from any Federal grain supervisor.

Determining dockage with the hand sieves.—If neither of the testers mentioned is available, approximate dockage determination can be made by hand sieves, using about $1\frac{1}{3}$ quarts of grain. The hand sieves usually employed with the various grains have been described on pages 22 to 24.

Determining dockage in wheat and rye with hand sieves.—If the sample contains coarse material, such as straw and sticks or oats and corn, this material may be removed, in part at least, by working the sample over the scalper sieve, known also as the $\frac{1}{64}$ -inch round-hole corn sieve. About one-fourth of the sample is placed on the sieve at a time. All threshed kernels of the grain being graded which remain on top of the scalper sieve should be picked out and returned to the cleaned sample. The coarse material is placed at one side for the time being and a further cleaning of the sample is accomplished with sieves of smaller-sized perforations. The $\frac{1}{12}$ -inch round-hole fine-seed sieve should be used except when wild buckwheat or other weed seeds of similar size and shape are present in a quantity in excess of 0.5 percent in wheat or in rye. For these exceptions the small buckwheat sieve is used.

About one-fourth of the sample is placed on it at a time and the sieve is shaken vigorously. The material that passes through the buckwheat sieve should be rescreened over the same sieve by placing not more than 50 grams of the material at one time on the sieve at the upper edge. Then, holding the sieve at an angle of 10° to 20° , the material is worked down over the sieve by a gentle side-sieving motion in such a way as to reclaim the grain. A second, or possibly a third, rescreening of the material that passes through the sieve may be necessary.

If at any time during the reclaiming procedure the material remaining on top of the hand sieve consists of more than 50 percent of dockage material, it is considered as dockage and no further reclaiming is done. The dockage will consist of all coarse material except wheat (if wheat is being graded) that was removed by the scalper, all fine dockage passing through the hand sieves in the process of reclaiming, and the material remaining on top of the hand sieve when such material consists of more than 50 percent of dockage material.

Supplementary sieving of wheat containing chess.—When the original sample of wheat contains more than 0.5 percent of chess, quackgrass, or other weed seeds of similar size and shape, dockage should first be removed with the scalper sieve and the $\frac{1}{12}$ -inch round-hole sieve. The wheat so cleaned is screened further with the large chess hand sieve. A portion of approximately 250 grams of the sample is placed on the hand sieve and worked back and forth lengthwise of the slots until all of the removable material has passed through the sieve. The operation is continued with similar-sized portions until the entire sample has been sieved.

The wheat that remains in the material passing through the hand chess sieve is then reclaimed in the following way: Using the hand sieve having $\frac{1}{12}$ -inch round-hole perforations (fine-seed sieve) held at an angle of from 10° to 20° , the material is placed on the lower edge of the sieve and the lower edge of the sieve is struck with one hand in such a way as to cause the material to bounce up and down. This will cause the chess, etc., to up-end and pass through the perforations of the sieve. The operation is continued until all the separable dockage material has passed through the sieve.

The material remaining on top of the fine-seed hand sieve is returned to the cleaned wheat. If the material that passes through the fine-seed sieve in the reclaiming process consists of 50 percent or more

of whole or broken kernels of wheat, it is put back in the cleaned wheat; otherwise it is added to the dockage material previously obtained.

In the case of rye containing chaff, quackgrass, or similar seeds, no attempt is made to remove such material by the use of the chaff sieves.

Determining dockage with hand sieves in barley.—The dockage in barley consists of coarse material like straws, corn, large soybeans, and barley heads removed by a metal scalper riddle sieve with slotted perforations nine sixty-fourths of an inch wide by three-fourths of an inch long; also of fine material such as weed seeds, dirt, etc., removed by a 20-gage metal sieve with equilateral triangular perforations, the inscribed circles of which are five sixty-fourths of an inch in diameter (small buckwheat sieve). The dockage also contains undeveloped, shriveled, and small pieces of barley kernels removed in the screening process, which cannot be recovered by properly rescreening with the small buckwheat sieve.

When barley is free of coarse dockage material the dockage may be determined rapidly at country points in conjunction with the sizing test for malting barley by (1) making the sizing test for barley as described on page 30, (2) sieving the thin barley kernels and other material removed in the sizing operation with a small buckwheat sieve for the purpose of removing fine dockage material, and (3) reclaiming with the small buckwheat sieve any thin barley kernels. The material so removed constitutes the dockage.

Method for making dockage tests on flaxseed.—If no Federal dockage tester is available, the removal of the dockage may be accomplished in two principal steps: (1) A mechanical separation is made with appropriate sieves and cleaning devices, and (2) a hand-picking separation of a portion of the mechanically cleaned flaxseed is made.

In making the mechanical separation enough flaxseed should be cleaned so that $1\frac{1}{8}$ quarts of flaxseed will be available for determining the test weight per bushel. Any combination of sieves and cleaning devices best suited to remove the type of foreign material present in the sample should be used for this purpose, and any flaxseed removed with the dockage should be reclaimed insofar as is possible by the use of appropriate sieves. The procedure, as a whole, should be such as to obtain results comparable with the results obtained in using the Federal dockage tester.

The hand-picking part in determining dockage in the mechanically (sieved) cleaned flaxseed is accomplished by obtaining a representative portion (not less than 15 grams) from the mechanically cleaned sample and separating by hand all the foreign material that remains. The dockage is then computed and expressed in whole percents, fractions of a percent being disregarded. The precise methods for computing flaxseed dockage, used by grain inspectors, may be obtained from any Federal grain supervisor.

Determining dockage in grain sorghums with hand sieves.—Sieving determinations for dockage and for total cracked kernels, foreign material, and other grains in grain sorghums are made concurrently by grain inspectors. They are best accomplished by using either the Federal dockage tester or the Emerson dockage tester. However,

the determination for dockage may be done by hand sieves and the determination for total cracked kernels, foreign material, and other grains may be done by the joint use of hand sieves and hand picking when dockage testers are not available.

When hand sieves are used for determining dockage in grain sorghums, the dockage consists of all that material that will pass through a hand sieve perforated with round holes two and one-half sixty-fourths of an inch in diameter. A representative portion of approximately 1,000 grams of the original sample is used for the hand-sieving operation. The hand sieve should be shaken vigorously with about one-fourth of the sample on the sieve at one time.

FOREIGN MATERIAL AND RELATED DETERMINATIONS

Total cracked kernels, foreign material, and other grains in grain sorghums.—The “total cracked kernels, foreign material, and other grains” in dockage-free grain sorghums includes all the matter that will pass through the small buckwheat hand sieve when operated in the same way as the dockage sieve described in the paragraphs entitled “Determining Dockage in Grain Sorghums With Hand Sieves.” In addition to the material so removed this factor also includes all material except grain sorghums and nongrain sorghums that remains on the small buckwheat sieve after the screening is done. To complete the determination for this factor, therefore, not less than a 50-gram representative portion of grain is taken from the sieved grain remaining on the small buckwheat sieve and is hand-picked for foreign material and other grains. The precise methods for computing “total cracked kernels, foreign material, and other grains” in grain sorghums, used by grain inspectors, may be obtained from any Federal grain supervisor.

Determination of cracked corn and foreign material in corn.—If neither the Federal nor the Emerson dockage tester is available a hand sieve perforated with round holes twelve sixty-fourths of an inch in diameter may be used for this test by sieving vigorously separate 200-gram portions of a 1,000-gram sample. Any cobs and matter other than corn that do not pass through the sieve are removed by hand and added to the matter that passes through the sieve. The percentage of cracked corn and foreign material is then computed from the weight of the material removed and the weight of the original sample used for the test.

Determining foreign material in wheat and rye.—For wheat, not less than 50 grams of dockage-free wheat are analyzed for determining the percentage of foreign material which includes all matter other than wheat, except smut balls, remaining in the wheat after the dockage has been removed. The portion of the sample that is used for this analysis may also be used for ascertaining the percentage of damaged kernels. A similar procedure is used for determining foreign material in rye.

Determining foreign material in barley.—Not less than 30 grams of the dockage-free barley are analyzed for determining the percentage of foreign material in barley. The 30-gram portion used for this purpose may be used also for determining the percentage of damaged barley in the grading of malting barley.

Determining foreign material in oats.—To determine the foreign material in oats a representative portion of at least 30 grams from the original sample is analyzed either by hand picking or by a combination of sieving with the small buckwheat sieve and hand picking. When the sieve is used, any oats that pass through the sieve are hand-picked and returned to the oats. Any foreign material that remains on the sieve is hand-picked and is added to the foreign material obtained by sieving. The total foreign material so obtained is then weighed, and the percentage thereof is computed on the basis of the portion of the sample used in making the test.

Determining wild oats in oats.—The percentage of wild oats in each numerical grade of oats is definitely limited. (See Handbook of Official Grain Standards.) The 30-gram portion described in the preceding paragraph may be used for determining the percentage of wild oats by hand picking and weighing.

Determining sound cultivated oats and sound barley.—The Federal standards for oats specify a minimum percentage requirement of sound cultivated oats in each of the numerical grades for oats. The percentage of sound cultivated oats in any sample is 100 percent minus the sum of the percentages (if any) of wild oats, foreign material, all damaged oats, and all grains other than oats. The same general procedure applies to the determination of sound barley except that the determination for barley is made after the dockage has been removed. (See the definition for Sound Barley in the Handbook of Official Grain Standards.)

TEST-WEIGHT-PER-BUSHEL DETERMINATIONS

To determine the test weight per bushel of any grain approximately $1\frac{1}{8}$ quarts of grain should be used. When this test is made with wheat, rye, or barley, the dockage must be removed before the test-weight-per-bushel determination is made. With corn and oats, for which there is no dockage provision, and with grain sorghums, the original sample of each of these grains inclusive of foreign material is used for making the test-weight-per-bushel determination. For flaxseed the test-weight determination is made after the removal of that part of the dockage which can be removed readily by the use of appropriate sieves and cleaning devices.

In making the weight-per-bushel test, the bucket of the testing device is placed beneath a funneled hopper having a capacity of approximately $1\frac{1}{8}$ quarts of grain. In the bottom of this hopper there should be an opening $1\frac{1}{4}$ inches in diameter. The bottom of the hopper must be placed 2 inches above the top of the bucket. The grain from the hopper is allowed to pour into the bucket until it overflows. Without moving or jarring the heaped bucket, the grain is leveled off with a special smooth round-edge stick in three zigzag strokes (fig. 2). The scale beam of the test-weight-per-bushel apparatus should never be used to level off the grain because the constant wearing effect on the beam and bucket will eventually affect the accuracy and because the square-edge beam has a tendency to hollow out the surface of the grain in the bucket which will cause a lower test-weight-per-bushel reading than does the official method.

DAMAGED AND HEAT-DAMAGED KERNEL ANALYSIS

Damaged and heat-damaged kernels for the different kinds of grain are defined in the Handbook of Official Grain Standards.

To determine the percentage of damaged kernels in any sample of grain, certain minimum quantities are taken of the various grains in accordance with the data in table 4. The percentage of heat-damaged kernels and the percentage of foreign material in samples of wheat, oats, rye, and barley may be determined at the same time and with the same portion of the sample that is used for determining damaged kernels. For determining total damaged kernels, heat-damaged kernels are included with all other kinds of damaged kernels but separate computations for heat-damaged kernels only must be made.

The official interpretations of just what are considered damaged kernels in grain inspection are conveyed to grain inspectors by means of type samples and by review of individual samples containing damaged kernels. The following descriptions of damaged kernels in wheat and in corn have been condensed from the Grain Inspectors' Manual.

Damaged kernels in wheat.—Damaged kernels shall be defined as kernels and pieces of kernels of wheat and other grains which are heat-damaged, sprouted, frosted, badly ground-damaged, badly weather-damaged, or otherwise materially damaged.

The following interpretations of damaged kernels apply to kernels and pieces of kernels of wheat and "other grains" that may be found in wheat.

Frosted kernels which are discolored black, brown, or green are considered as damaged.

Frosted kernels having frost blisters extending around the back of the kernel and into the crease are considered as damaged. (Otherwise sound kernels of good healthy color having a slight bran frost are not considered as damaged.)

Frosted kernels having the bran coat partially flaked off are considered as damaged.

Frosted kernels having a distinctly waxlike or candied appearance are considered as damaged.

Kernels which have been bored by insects are considered as damaged. (Kernels otherwise sound which are only slightly eaten by insects are considered as sound.)

Sprouted kernels are considered damaged. Kernels will be deemed sprouted when the germ end has been broken open from germination. All kernels having the appearance of having been sprouted although the sprout may have been broken off, are considered as damaged. (Kernels of wheat which do not have the appearance of having sprouted and are otherwise sound, except that the germ end has been eaten out by the cadelle worm or other insect, are considered as sound.)

Kernels affected by scab where the bran coat of the kernel is broken open and showing evidence of mold, or other diseased or damaged condition, are considered as damaged.

Kernels having a dull, lifeless, chalky appearance, or so-called tombstone appearance as the result of disease are considered as damaged.

Kernels affected by black-tipped fungus where the fungus growth extends over the germ and down into the crease of the kernel are considered as damaged.

Kernels which are materially affected with white, pink, grey, black, or green molds are considered as damaged. (Weather-bleached kernels unless otherwise damaged are considered sound. Immature kernels discolored pink by hot wind but with no evidence of mold or other damage are considered as sound.)

Kernels having a dull, lifeless appearance accompanied by a moldy appearance of the germ or accompanied by mold in the crease are considered as damaged.

Kernels having a discoloration of the body of the kernel (slightly heat-damaged, but not materially discolored from heat) as a result of incipient fermentation, or kernels having a moldy or materially damaged appearance of the germ, or having mold in the crease are considered as damaged.

Kernels which are green colored from immaturity or which are materially damaged from causes other than those listed are considered as damaged.

Kernels and pieces of kernels of wheat and other grains which have been materially discolored by external heat, or as a result of heating caused by fermentation are considered damaged and also heat-damaged.

Damaged kernels in corn.—Damaged kernels are defined as kernels and pieces of kernels of corn which are heat-damaged, sprouted, frosted, badly ground-damaged, badly weather-damaged, or otherwise materially damaged.

The term "otherwise materially damaged" in the definition for damaged kernels of corn is clarified by the following interpretations:

In general, a kernel of corn is considered to be damaged for inspection and grading purposes only when the damage is distinctly apparent and of such character as ordinarily to be recognized as damaged for commercial purposes.

Kernels of corn, the germ of which is affected with the mold commonly known as "blue eye," are considered as damaged.

Kernels of corn having damaged germs are considered as damaged.

Weevil-bored kernels of corn described below are considered as damaged.

1. Kernels which bear evidence of boring or tunneling indicating the presence within the kernel of insects, insect webbing, or insect refuse; and,

2. Kernels in which noticeable weevil-bored holes have been eaten and in which webbing or weevil refuse still remain.

(Kernels which have been insect-eaten but which are entirely free from refuse, webbing, or insects are considered as sound. Kernels of corn having surface mold growths which have not penetrated the kernels sufficiently to injure them shall be considered as sound kernels, provided the kernels are otherwise sound. So-called "silk cut" kernels not otherwise damaged are considered as sound kernels.)

Kernels of corn which have been damaged by heat, but are not distinctly discolored, function only as damaged.

Kernels of corn which have been materially discolored and damaged by external heat or as the result of heating caused by fermentation, are considered damaged and also as heat-damaged.

MISCELLANEOUS DETERMINATIONS

Shrunken and broken kernels in wheat.—To restrict objectionable mixtures of shrunken and/or broken kernels of wheat with wheat of high test weight the standards provide for a 7-percent limitation on shrunken and/or broken kernels in the top grades for each class of wheat and a 10-percent limit in the third grade (No. 2 grade is the third grade in the class Hard Red Spring). This grading factor includes shrunken and/or broken kernels of grain and other matter that will pass through a 20-gage metal sieve with slotted perforations 0.064-inch wide by $\frac{3}{8}$ -inch long (small chess sieve). In addition to these limitations, the standards for Durum wheat and for Red Durum wheat limit not only the percentage of shrunken and/or broken material that will pass through the sieve, but also the broken kernels of grain of any size that remain on the sieve. For these two classes of wheat the percentage of the combined shrunken and/or broken kernels that pass through the sieve and the broken kernels that stay on the sieve is limited to 10 percent in grades 1 and 2 and to 15 percent in grade 3. In all classes of wheat other than Durum and Red Durum, the limitations regarding shrunken and/or broken kernels apply only to the material that will pass through the sieve.

For all wheats except Durum and Red Durum the sieving is performed by placing approximately 250 grams of the dockage-free wheat on the small chess sieve held level and shaking the wheat 30 times (left to right and return) from side to side across the sieve in a steady manner and so that the grain moves lengthwise of the slots. For wheat of the Durum and Red Durum classes 50 grams of the dockage-free sample are sieved as described above and this operation is supplemented by hand picking the broken kernels from the grain remaining on the sieve.

Odors in grain.—The official grain standards provide that musty or sour grain, or grain that has any commercially objectionable foreign odor, except of smut or garlic, shall be graded Sample grade. Musty or sour odors in grain are the result of mold growth or of fermentation and heating, and are indexes of deterioration in grain quality that materially lowers its value to grain users. Commercially objectionable foreign odors in grain result from the absorption by grain in railroad cars and other containers of residual odors from commodities like hides, oil, and fertilizers previously stored in such containers. The principal reasons for including such grain in Sample grade are that in case of wheat or rye the odor usually is carried into the flour and in case of the feed grains the odor adversely affects the palatability and in extreme cases the actual feed value.

When grain is being tested for these odors the original sample should be carefully examined for odor before there is any cleaning or sieving of the grain and before the grain has been exposed to the air for any considerable length of time. If it is impracticable to make this test at the time of sampling or immediately after the sample arrives in the laboratory, a representative portion of the

sample should be placed in an airtight container until conditions permit the test to be made properly.

General appearance as a grade factor.—The official standards provide that slightly weathered oats and badly stained or materially weathered Feed Oats and Mixed Feed Oats shall not be graded higher than No. 3 and that badly stained or materially weathered oats or barley, except Western Barley, shall not be graded higher than No. 4. Badly stained or materially weathered Western Barley is designated by the special grade designation "Stained."

INCREASING THE VALUE OF GRAIN

The grading factors discussed in this publication measure class, quality, and condition and are the basis on which inspectors assign grades to grain. Many of the conditions that are measured by these grade-determining factors are under the control of the farmer or grain handler. Examples of the conditions that are under the control of the farmer or grain handler are as follows:

Wheat may be assigned a lower grade because it is composed of a mixture of different classes, or because it contains an excess quantity of rye, weed seeds, or smut. Grain is sometimes assigned a low grade because it has a musty odor or because it contains an excess quantity of damaged kernels as a result of the grain having been put into storage while it was still too damp. Barley that has been threshed too closely may not qualify for the highest classification or the highest grade.

Good farm practices.—The selection of suitable varieties, the recommended cultural methods, proper seed treatment, harvesting when the grain is mature, careful threshing and subsequent handling, all have an important influence on the elimination of factors which lower the grade and value of the grain crops.

The improved quality of market receipts of grain in recent years is noticeable. Some areas have eliminated rye mixtures in wheat. Chess and cockle have been cleaned out in others. The top grades of malting barley are now produced where "feed" barley formerly was grown. The quality of corn shipped to market now averages high with much of it in the No. 1 grade.

The educational work conducted by State extension and crop improvement organizations has accomplished much in increasing the quality of the grain produced. By encouraging the farm practices which are beneficial to both the producer and the buyer, grain of higher grade has been grown and marketed. The entire industry has benefited.

ANALYTICAL PORTIONS

In the standard grain-inspection procedure all determinations that are based on fractional parts of a sample are made on standard-sized portions (table 4) cut from the sample by means of the Boerner divider. When the grade of any lot of grain is determined by a narrow margin, on a single grading factor, another determination is made on an additional portion and the grade is based on the average of the two determinations.

TABLE 4.—*Minimum quantity of grain in analytical portions recommended for inspection work*

[Quantities in grams (metric) unless otherwise stated]

Determination for—	Wheat	Corn	Oats	Rye	Barley	Grain sorghums	Flaxseed
	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>
Blight.....	25	250	25		30	25	
Class.....	25				30		
Color and texture.....							
Cracked corn and foreign material ¹		1, 000				² 1, 000	
Dockage ³	⁴ 1½			⁴ 1½	⁴ 1½	1, 000	⁴ 1½
Ergot.....	250		250	250	250		
Foreign material.....	50		30	50	30		
Garlic.....	1, 000		500	1, 000	500		
Heat damage.....	50	250	30	50	⁶ 50	50	20
Kind of grain.....	50	250	30	50	30	50	25
Mellow.....					⁶ 50		
Nongrain sorghums.....						50	
Shrunken and/or broken kernels:							
All classes (except Durum and Red Durum).....	250						
Durum and Red Durum.....	⁷ 50						
Sizing.....			⁴ 1½		⁴ 1½		
Skinned and broken.....					30		
Smut.....	250		500	250	500	250	
Smut dockage.....	500						
Sound.....			30		30		
Stones and cinders.....	1, 000	1, 000	1, 000	1, 000	1, 000	1, 000	
Total damaged.....	50	250		50	30	50	20
Two-rowed.....					30		
Weevil.....	1, 000	1, 000	1, 000	1, 000	1, 000	1, 000	
Wild bromegrass.....			1, 000		1, 000		
Wild oats.....			30		30		

¹ Refers to "total cracked kernels, foreign material, and other grains" for grain sorghums.² 50 grams of sieve-cleaned grain are also hand-picked for additional foreign material and other grains.³ A sufficient quantity is used to provide at least 1½ quarts of grain for the weight-per-bushel test.⁴ Quarts.⁵ At least 15 grams of sieve-cleaned grain are also hand-picked for additional dockage material.⁶ Weight before pearling.⁷ In Durum and Red Durum wheat the sieving operation is supplemented by hand picking of the broken kernels that do not pass through the sieve.

FURTHER INFORMATION

The information contained in this publication pertains to the most important grading problems that are encountered in grain inspections. Local and seasonal conditions may require some other special grading procedure than is here described, but it is believed that the abbreviated instructions and definitions in this publication should prove useful to those grain producers and handlers who are not familiar with the full technical routine employed by official grain inspectors.

Federal grain supervisors are located at most of the large grain markets. Upon request they will give advice and further information regarding grain-grading problems. In addition, licensed grain inspectors are located in nearly every terminal grain market, so that approximately 140 grain-inspection offices and laboratories are available throughout the country for this purpose. It is suggested that anyone who is interested in this subject visit one or more of these grain-inspection offices and observe the way in which grain is sampled, inspected, and graded, under commercial conditions.

OFFICES OF THE AGRICULTURAL MARKETING SERVICE AT WHICH
FEDERAL GRAIN SUPERVISORS ARE LOCATED

(FEBRUARY 1940)

Albany, N. Y.: Post Office Box 941.
Baltimore, Md.: 801 Appraisers Stores.
Boston, Mass.: 701-A Customhouse.
Buffalo, N. Y.: 340 Post Office Building.
Cairo, Ill.: 6 Post Office Building.
Cedar Rapids, Iowa: 200 Post Office Building.
Chicago, Ill.: 332 South La Salle Street, Room 1145.
Cincinnati, Ohio: 509 Post Office and Courthouse.
Denver, Colo.: 573 Customhouse.
Duluth, Minn.: 338 Post Office Building.
Enid, Okla.: 1112 Bass Building.
Fort Worth, Tex.: 404 United States Courthouse.
Galveston, Tex.: 216 Post Office Building.
Great Falls, Mont.: 251 Post Office Building.
Indianapolis, Ind.: 523 Post Office Building.
Kansas City, Mo.: 325 United States Courthouse.
Los Angeles, Calif.: 1534 Post Office Building.
Louisville, Ky.: 301 Post Office Building.
Memphis, Tenn.: 104 DeSoto Post Office Building.
Milwaukee, Wis.: 345 Federal Building.
Minneapolis, Minn.: 116 Federal Office Building.
Nashville, Tenn.: 319 Chamber of Commerce Building.
New Orleans, La.: 313 Customhouse.
New York, N. Y.: 90 Church Street, Room 1004.
Ogden, Utah.: 314 Post Office Building.
Omaha, Nebr.: 508 Federal Office Building.
Peoria, Ill.: 355 Post Office Building.
Philadelphia, Pa.: 1004 United States Customhouse.
St. Joseph, Mo.: 331 Post Office Building.
St. Louis, Mo.: 1001 Courthouse and Customhouse.
San Francisco, Calif.: 568 Federal Office Building.
Seattle, Wash.: 534 Federal Office Building.
Sioux City, Iowa: 208-212 Post Office Building.
Spokane, Wash.: 710 Peyton Building.
Toledo, Ohio: 310 Courthouse and Customhouse.
Wichita, Kans.: 230 Post Office Building.
General field headquarters, Chicago, Ill.: 1108 Post Office Building.
Pacific coast field headquarters, Portland, Oreg.: 345 United States Court-
house.

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